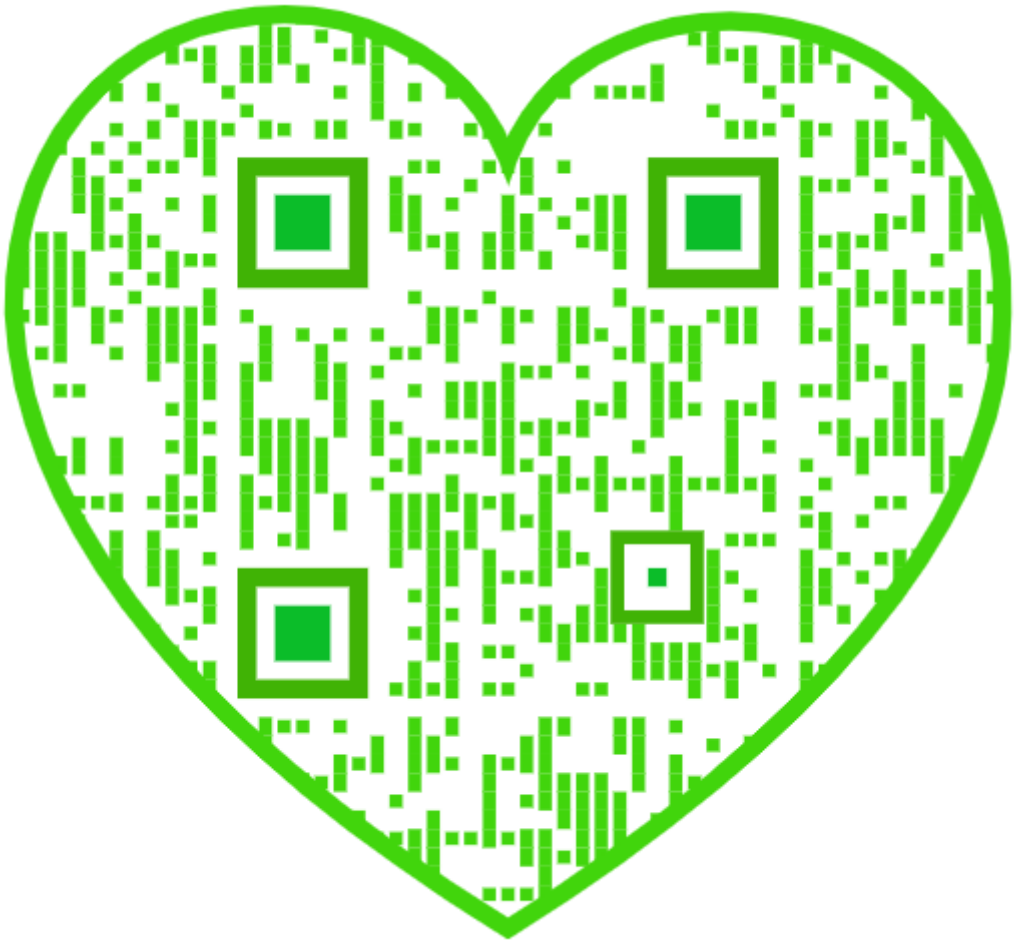

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DEPARTMENT OF AGRICULTURE.

FIBER INVESTIGATIONS. REPORT NO. 1.

A REPORT

ON

FLAX, HEMP, RAMIE, AND JUTE,

WITH

CONSIDERATIONS UPON FLAX AND HEMP CULTURE IN EUROPE,
A REPORT ON THE RAMIE MACHINE TRIALS OF 1889
IN PARIS, AND PRESENT STATUS OF FIBER
INDUSTRIES IN THE UNITED STATES.

BY

CHARLES RICHARDS DODGE,
SPECIAL AGENT.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF ASSISTANT SECRETARY,
Washington, D. C., March 10, 1890.

SIR: I have the honor to transmit herewith for your approval the special report on fiber investigations made in pursuance of your instructions, by Mr. Charles Richards Dodge, under my direction.

The interest in this subject is widespread, and the inquiries which have reached me in regard to it are numerous.

I take pleasure in recommending its early publication.

I have the honor to remain, sir, yours respectfully,

EDWIN WILLITS.
Assistant Secretary.

Hon. J. M. RUSK,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
March 1, 1890.

SIR: In accordance with instructions in my commission from the Secretary of Agriculture, under date of July 11, 1889, I have the honor to submit herewith a report embodying the account of my investigations and studies in Europe last season, in relation to flax and hemp culture, and flax and ramie machinery and processes, together with special chapters on the present status of the flax, hemp, ramie, and jute industries in the United States. In the preparation of this document many interesting and useful facts have been omitted necessarily, for reasons given in my introductory remarks, but I trust enough has been presented to fully answer the questions of the many correspondents of the Department, and others, who are seeking information relating to these fibers, at the present time.

I am, sir, respectfully yours,

CHARLES RICHARDS DODGE,
Special Agent, In charge of Fiber Investigations.

Hon. EDWIN WILLITS,
Assistant Secretary.

INTRODUCTION.

During the season of 1889 I spent some six months in Europe, where, among other things, I was commissioned to study the foreign practices or methods of fiber culture, chiefly of flax and hemp, and to investigate the new machinery for the cleaning of these fibrous plants, as well as the important machines or processes for the decortication of ramie. Through my official connection with the American Commission to the Paris Exposition, many facilities for the pursuit of this undertaking were afforded which otherwise might not have been available, and through which I was able to secure much valuable information. At the close of my labors in behalf of the American Commission, the inquiries were continued as a special agent of the Department of Agriculture, and on my return to the United States in November last, a similiar line of investigation was entered upon for this country, with a view to bringing the knowledge of the progress and present status of the fiber industry, on both sides of the ocean, up to date. It was intended to embody this information in a special report, to be published at an early date, and which should cover the ground as completely as possible. As the work proceeded, however, and was pushed in different directions, it soon appeared that only a small part of the valuable material which would be available could be published in a bulletin of forty or fifty pages, as originally intended, and to wait for the completion of the full report would delay too long the printing of the special information obtained abroad, which it was desired to publish at once. The present report is issued, therefore, as preliminary to the final report, in which not only flax, hemp, ramie, and jute will be treated as fully as possible, but many other fibers of commercial interest, or that might from their cultivation add to the resources of our country.

The present report is arranged in two parts, the first relating to fiber matters and machines in Europe, while in the second is presented some interesting facts regarding the present status of flax and hemp cultivation in the United States, together with some important statements bearing upon ramie. Much interesting material upon the subject of indigenous fiber plants, or others which might be successfully cultivated here, has been collected, but this must necessarily await the publication of the later report.

Before closing, I wish to make my acknowledgments to the following persons to whom I am especially indebted for favors or assistance in the prosecution of my investigations abroad. To General William B. Franklin, commissioner-general of the United States to the Paris Exposition of 1889, for his kind co-operation in and hearty appreciation of the work in hand. In France, to M. Leopold Faye, minister of agriculture, M. Eugene Tisserand, director of agriculture, and M. Henri Grosjean, inspector of agricultural instruction, for official papers and special information. To M. P. A. Favier, of Paris, for statements regarding ramie culture and manufacture, together with a complete series of specimens. To Alfred Renouard, jr., of Lille, for references and information. In Belgium to M. J. Cartuyvels, director of the administration of agriculture, for sets of official documents, and to M. Paul De Vuyst, state agronomist, and to Prof. Adolphe Damseau, director of the state agricultural experiment station, who visited with me some of the flax fields of the Brabant, and furnished me with valuable facts regarding the special practice in this district and in other portions of Belgium as well. To M. Frederick D'Hont, director of the communal laboratory of chemistry and agriculture at Courtrai, through whose untiring endeavors I was enabled to learn much regarding the culture and management of flax in Flanders, and especially of the treatment of flax along the River Lys.

For valuable aid and kind offices in England I am indebted to Dr. D. Morris, assistant director of the Royal Gardens, Kew, and to Edmund J. Moffat, United States deputy consul-general, London, for assistance and favors. In Ireland I was placed under obligations to Mr. John Orr Wallace, Mr. William Morton, secretary of the Flax Supply Association, to Mr. F. W. Smith, editor of the Irish Textile Journal, and to Mr. J. Carmichael Allen, for useful information, statistics, and documents. And I gratefully recall the memory of another Belfast gentleman whose acquaintance was made in Paris, and to whom I was indebted for much that made my brief stay in Ireland pleasant and instructive, and through whose influence doors were opened to me that might otherwise have remained closed, the late William K. Brown, J. P., of the firm of John S. Brown & Sons.

To the flax and hemp manufacturers and growers in the United States, the ramie experimenters, and all others in this country, who have taken an interest in the present investigation, or have in any way aided in the work, I beg to make acknowledgment, and to thank them for their kind efforts in behalf of American agriculture.

PART I.

FIBER INDUSTRIES IN EUROPE.

FLAX CULTURE IN EUROPE.

PRACTICE IN BELGIUM.

The finest flax grown in Europe is unquestionably produced in western Belgium, and largely in a region of country through which flows the River Lys, the town of Courtrai being the center of the industry. This is the creamy Flemish flax, from which the finest linen fabrics are made, and which owes its peculiar color to the waters of this famed stream, "the golden Lys," in which the Courtrai flax is always retted. Flax is grown, however, in other sections of Belgium, a fine flax, but darker in color, coming from the country of Waes, and retted in stagnant water in specially constructed "pools." In the Brabant, too, considerable quantities of flax are grown, both dew and pool-retted, and known as "blue flax" from its very dark color.

Desiring to know by personal experience something of the peculiar methods of handling flax in the Belgium flax-growing districts I visited several of the most important centers of the industry about the 1st of September, 1889, at which time the river retting, as practiced in Courtrai, is in full operation. Through the courtesy of Belgian officials and others I was able not only to see the various operations after harvesting that it was desirable to study, but to learn much that was interesting regarding cultivation and the industry in general.

While the superior quality of Courtrai flax is claimed to be due chiefly to the action of the soft, slowly running, almost sluggish waters of the River Lys, without doubt there are three other important factors which aid in the result: First, a soil preparation, with systematic rotation of crops and extent of fertilizing that few, if any, flax farmers in America have ever practiced; second, the use of only the best seed; and lastly, most careful handling and skillful manipulation from the time the crop is ready to pull until the straw goes to the scutch mill. Nor is the care and vigilance relaxed even here.

I was informed that flax succeeded best in a deep and well-cultivated soil that is not too heavy, experience proving that in a dry calcareous soil the stalk remains short, while in heavy clayey soil it grows very long, although its fiber is not so fine. The ground is plowed either in the fall or spring—plowed or spaded, for a great deal of the flax land

is turned with the spade. The work may begin in November, sometimes a little earlier, or it may be put off until February or the first days of March. I was told that both methods had their advocates and opponents, and that either season may be advantageous or disadvantageous, according to the kind of winter which follows or precedes.

In the matter of enriching the soil there is no half-way work or turning "short corners." Where stable manure is used it is generally put on before winter sets in. Then in spring before sowing time the ground is heavily treated with fertilizers, or night-soil in solution is poured over it. A great deal of the material is brought from the towns and kept in closed receptacles or reservoirs until the time for using it on the ground. Stable manures are used in connection with chemical fertilizers. Of the latter it is common to employ from 600 to 800 kilograms per hectare, or roughly, from 500 to 750 pounds per acre, and to go over the ground with the liquid night-soil in addition.

But the Belgian flax farmer does not depend upon careful fertilizing or cultivation alone to put the soil in the proper condition for growing flax, a careful system of crop rotation playing a very important part. Regarding the precise order of rotation and even the length of time between two growths of flax on the same land, there is the greatest difference of practice in the several districts and even in different towns of the same district, so no one absolute course of cropping can be laid down. In the Courtrai region the occupancy of the land with flax varies from five to ten years, the average being about eight. In eastern Flanders it is five to nine, and in the Brabant five to eight. In some other sections a much longer time elapses between two crops of flax, and one or two generations back fifteen and even eighteen years were sometimes allowed to intervene.

One informant stated to me that flax was most generally sown after leafy plants, such as potatoes or turnips, wheat and especially oat stubble being highly approved. A common rotation is clover, oats, rye, wheat, and in some cases hemp. Crops of rape, tobacco, beans, and vegetables (these latter crops on farms contiguous to towns) or even onions and salsify, are grown, as in middle Belgium. Clover is considered one of the best crops to precede a crop of flax, as its numerous roots go deep into the soil and from their decomposition not only furnish nutriment to the growing flax roots, but enable them more easily to push down into the soil. In the pamphlet of instructions published by the Irish Flax Supply Association, the Belgian rotation is given as flax following corn (grain not maize) after potatoes, mangold, or beet, clover not being mentioned at all.

After spading or plowing, the ground is well broken with the harrow, oftentimes being brought almost to the condition of garden soil. It is then rolled and the seed planted, this being done any time from the last week in February until the latter part of March, dependent upon the weather.

It is considered of prime importance that a good quality of seed be used, and in Belgium the greatest care is taken—I might almost say utmost vigilance is exercised, because so many frauds are perpetrated—to secure only such a quality of seed as will give the best results. The appearance of the grain, its richness in oil, the absence of all foreign odors indicating mustiness or bad condition, purity, and its germinating power, are all considered, and no test neglected that will enable the cultivator to assure himself as to what he is buying. Limited space necessitates dismissing this subject of the selection of seed thus briefly, though the editor of the Irish Textile Journal dismisses it more briefly, as follows:

> Select your seedman, for it is an open secret in this age of commercial shams, an old or inferior article can be made to look almost equal to new.

The most common and the best course is to import the seed annually, though I found that in some localities a different custom prevailed, as in the Brabant. Imported seed is planted the first year, Dutch or Russian, and the seed product of this crop planted the second year, giving, it is claimed, a better quality of flax than the first year; but for the next year's sowing new seed is again secured. This is due to the deterioration of the home-grown seed, from the flax being pulled before it is fully mature. And as seed grown in parts of Russia, notably around Riga, attains the most perfect state of maturity, it is considered the best practice to renew annually with the fully matured seed. The sowing must be done with great regularity, the best results being attained only with long experience. I understand that a great deal of this work is done in Flanders by special workmen, who, in the flax-sowing season, make it a business, receiving their pay, not by the day, as is usual in this country, but by the number of hectares[1] sown.

The seed is most usually sown in the morning and harrowed with a harrow set with very close teeth. This is considered necessary for giving a uniformity to the stand of flax in the field, insuring the same standard of fineness in the ultimate product for every part of the field.

The amount of seed sown varies ordinarily from 2½ to 3 bushels per acre, though in one district (Hainault) it is claimed that the quantity sown is sometimes double this amount. Probably 3 bushels per acre comes nearer the general practice. Some growers hold that more should be used when the sowing is late than when early; at any rate, when planted too thickly, as is sometimes the case, it is afterwards thinned, though such a practice of course adds just so much more to the cost of production.

After the seed has germinated and the plant is about ready to appear above ground, or sometimes even after it has sprouted, the land is rolled, partly for the purpose of laying the soil firmly and partly to make the surface even to facilitate the next operation that demands the

[1] A hectare is 2.471 or almost 2½ acres. All calculations in this report are made on the basis of 2½ acres.

cultivator's attention, the weeding; this is done by women chiefly at a time when the flax plants are from 3 to 6 centimeters high (approximately 1 to 2½ inches), or at the end of eight to ten days from time of sowing. The women (sometimes men or boys) work upon their knees in this operation, proceeding against the wind in order that the plants may soon be blown or returned to their normal position again. Some attention is also paid to the time of weeding, as neither a too wet nor too dry condition of the soil is desirable. On good soil, from which weeds have been pretty well eradicated by thorough culture, one weeding suffices, though occasionally two and even three weedings are necessary.

Of the diseases that flax is heir to in Belgium nothing can be said here, owing to limited space. As to accidents due to meteorological causes, as high winds straining and toughening the stems, or heavy rain-storms, which sometimes cause the flax in a whole field to lodge or break down, or hail, which play worse havoc, there is little that can be done in such cases. Professor Damseau, of the State agricultural experiment station at Gembloux, informed me that hail does great injury to the growing flax, even when the stalks are not broken, owing to the fact that where the straw is struck by the hailstone a knot or knob forms which "breaks the length" in the final operations of cleaning and dressing. In case of total destruction, when the flax is not more than a foot high, a crop has sometimes been secured by immediately cutting it down to a couple of inches all over the field and letting it grow up again.

In Flanders, and throughout Belgium as well, the seed is of secondary importance, and therefore to obtain as fine and strong a fiber as possible the flax is pulled before it is fully ripe, or when it is just beginning to turn yellow, coarse flax ripening earlier than fine. The work is done (or begins usually) the last week of June, sometimes a little earlier, for, as the old proverb runs, "*C'est Juin qui fait le lin*" ("June makes the flax").

The flax is pulled with great care, the ends being kept very even, and the straw laid in handfuls upon the ground, a line of straw first being laid down, which serves to bind these handfuls when a sufficient quantity has been pulled to tie. When put into stooks to dry, the seed ends being tied together, the bottom ends are opened out, giving to the stook the appearance of an A tent. After drying in the stook the handfuls of straw are then tied into small bunches or "beets" and piled, something as cord-wood is piled in this country, two poles being first laid upon the ground to prevent injury to the bottom layer by dampness, and two poles driven at each end of the pile to keep the "hedge" in form.

In piling it is the custom to reverse the beets in alternate layers; before the top layer is put on a row of beets is laid lengthwise near the edge of the pile, so that the top layer will be given the proper slant to

shed the rain. The flax is left in this position for several weeks, and then either retted very soon or put into immense stacks, or sometimes into sheds, to remain till spring. I found a great diversity of practice in different sections in the method of handling the flax after pulling and before the retting.

The practice detailed above pertains to Flanders more especially, while in the Brabant and elsewhere a very different practice prevails.

M. DeVuyst, of the State agricultural inspection, with whom I visited a flax-growing locality in the Brabant, informed me that the seed is usually removed soon after the flax is pulled. A common method of accomplishing this is to draw the heads through a hetchel or comb of square iron pickets some fifteen inches high. These pickets are about half an inch wide at base, and, as they are pointed at the top, the spaces between them grow narrower as the bottom board into which they are driven is approached by the head of the bundle of flax straw, and the seed capsules are detached. When the seed vessels are dry, they are threshed with an instrument made from a square block of wood, either flat on the bottom or fluted to form coarse teeth, a curved handle being mortised into the top. In a scutch-mill near Gembloux I witnessed two other methods of getting out the seed, this being accomplished in the first instance by means of a machine with large crushing-rolls, the ends of which were free at one side of the piece of mechanism, in such manner that only the heads of the flax could be passed through, the bundle of straw remaining uninjured in the operator's hands. Two or three times passing through sufficed to crush the capsules and clear the seed perfectly. The other method was to go over the straw with a heavy roller upon a slatted floor, through which the seed and chaff fell. In Courtrai the seed is usually mauled out with the contrivance described above. This is done in sheds for the most part or on floors, though I have seen the work going on out of doors at the side of the highway, or on the stone paving in front of the peasants' cots.

There are three systems of retting practiced in Belgium, the dew retting most commonly followed in the neighborhood of Brussels, and in the flax district I visited near Gembloux; the retting in crates anchored in running water (*rouissage au ballon*), as practiced in the River Lys, in Flanders, and the system of plunging the flax straw into pools or cisterns as soon as pulled, which pertains in the Waes country and some other sections. The dew retting need not be described here, as it is the usual practice in our own country, giving an uneven and least valuable product of all methods of retting. In the pool retting the pits or reservoirs are dug some months in advance, so that the loose earth will have been washed from the walls and they will be clean. They are of varying dimensions, and are sometimes divided into several compartments by partitions these are formed either of boards or walls of sod, or of earth, the bottom being very clean. Sometimes alder fagots are placed with the flax to influence its color, slight differences in color depending

upon many things, all of which are taken into consideration by the operator. The first process is to secure the seed, as has been described, after which the flax is again bound into small bundles, which must be neither too light nor too loose, so that the water will penetrate them freely after they have been placed in the pits. To keep the bundles under water they are covered with a layer of straw, on which sods, or in some localities stones or boards, are placed. Precisely how long the flax should be allowed to remain in the water must be determined by the operator; five to ten days is the range, the quality of the growth itself, the weather, and other circumstances all being considered. A farmer learns by experience when the flax is sufficiently retted to raise, though tests by breaking a few stalks from time to time must be made. After being "washed out" or "taken out of the rot," and while still wet, the straw is spread upon the neighboring fields to dry, or in order that the process of retting may be completed; the precise duration of time necessary for this operation is also determined by various circumstances. By breaking a few flax stalks or rubbing them between the palms of the hands, however, the farmer can judge pretty nearly when the crop should be housed.

The Courtrai method of retting is the most interesting, though not as important to us, for (presumably), there is no River Lys in America, and if there were one, it would not be desirable to use it for retting flax. There is but one Lys in Belgium, a dark and murky stream, with sullen flow, its waters an indescribable greenish hue, and its odor as pronounced as its color, yet to its banks comes the flax of this entire region, by the wagon-load, by the car-load, and even by railway trains of twenty to thirty cars, loaded like hay, though in the regulation bundles, and covered with large oil-cloths or tarpaulins. I shall never forget my first walk up the Lys on a bright September afternoon in company with M. Frederick D'Hont, director of the Communal Laboratory of Agricultural Chemistry, Courtrai.

But 3 miles of the right bank of the river was traversed, though the flax industry occupies its banks for 20 miles. On both sides of the narrow stream, reminding one of a canal more than a river, though there was no tow-path, back for 50 rods or more, and as far into the distance as the eye could reach, one saw only flax. There were the immense stacks containing tons and thatched as carefully as the roofs of the peasant cottages. There were acres of "hedges," as the "cord wood" piles are called, and long lines of the big bundles made up ready for immersion, while farther back in the fields were the opened bundles or beets, tied at the top and spread apart at the bottom in circular form, like bell-tents, the plan always adopted for drying the flax that has been immersed. This is the manner of packing the bundles for immersion: Crates or frames of wood are used, having solid floors of boards, the sides being open. These measure about 12 feet square and perhaps a meter in height, or a little over a yard. First a strip of jute burlap is

carried around the four sides, on the inside, coming well to the top rail of the crate. This is to strain the water, or to keep out floating particles or dirt which would injure the flax by contact with it. The bundles, which measure 8 to 10 inches through, are composed of beets laid alternately end for end, so that the bundle is of uniform size throughout. They are stood on end and packed so tightly into place that they can not move, each crate holding about 2,000 to 3,000 pounds of straw. When a crate is filled the entire top is covered with clean rye straw and launched and floated into position in the stream. It is then weighted with large paving blocks or other stones until it has sunk to the top rail, when it is left for the forces of nature to do the remainder. The time of immersion is from four to fifteen days, dependent upon temperature of the water and of the air, quality of flax, and other influences. There are several delicate tests which indicate when the flax should come out, although the near approach of the time is made known by the self-raising of the crate out of the water (often a foot or more), caused by the gases of decomposition.

When ready to remove, the crate is floated opposite a windlass, and there are many along the shore, the chain attached, and the affair pulled half way up the bank, when the bundles are at once removed. The big bundles are taken back to the field and are now broken up and again put into the form of the little bell-tents described above. This work is done by boys, who show great dexterity not only in spreading and standing up the little bundle when it is first opened for drying, but in the subsequent operation of turning the tent completely inside out, so that the straw that was shaded in the interior may be subjected to the air and sunshine and the drying be accomplished evenly.

After this drying process is completed, the flax again goes into the big bundles for a second immersion, and I was told sometimes a third, though rarely. This work begins in September and continues until too cool to ret the flax advantageously. Then it begins again in March and continues until all the flax has been retted. Much of the unretted flax is carried over to the next year in this manner. Not only is it thought to improve the flax in quality, but is better for the producers, enabling them to hold their product for good prices when the fall prices are low.

Formerly the farmers did the principal part of the retting, selling their crop to the merchants in the form of fiber. I was told that this custom no longer prevails, the work now being carried on wholly by the flax merchant, who either buys the pulled straw of the farmer or purchases the standing flax, in the field, his own employés doing the pulling. When the farmer does the pulling he hauls the crop to the Lys, unless he wishes to hold it over, securing the market price that prevails at the time. Many flax merchants are also owners of scutch mills, and have charge of the entire manipulation from the time the crop is ripe until the cleaned fiber is sold.

I visited one of these scutch mills in the little hamlet of Waverlyhem,

and witnessed with pleasure the entire process of converting the clear, glistening, almost white straw, into the beautiful semi-golden line fiber which distinguishes the flax of western Flanders. The rude machinery was run by steam, the brake being a primitive affair, with simple fluted rollers, but which did their work perfectly, however, largely due to the splendidly-prepared fiber which the operator had to work upon.

There is little hand scutching in Belgium at the present day, although the scutching machines in general use are of the simplest form. Through the center of the mill is arranged a line of scutching berths before which, or rather in which, each operator stands. A single shaft runs through the structure from end to end, and at each berth is arranged a breaker-wheel, or simple iron frame (called a "wiper-ring"), to which is affixed the beating-blades, made of wood. These are about 3 feet long and 4 or 5 inches wide, there being ten blades to each wheel.

These arms or blades revolve at the rate of 300 to 400 revolutions per minute, dependent upon the quality of flax being cleaned, and move parallel with an upright partition of iron or wood, in which there is a wedged-shaped opening, the lower edge being horizontal and a little above the center of the shaft. The "boon," or broken woody portion of the straw, and the dust are carried back by the whipping action of the beaters or blades, as the broken flax is projected through the wedge-shaped opening, and falls into the deep space beneath. As a handful of flax is beaten or "buffed," first one end and then the other, a certain amount of fiber is whipped off, known as scutching tow, or in Irish scutch-mills as "codilla." This should not be confounded with the tow proper, which results from dressing or hackling the cleaned fiber, nor with the product of the western tow-mills in our own country.

When the handful of flax has been properly buffed, it is snapped or shaken and passed to a second man, who finishes the operation of cleaning on another wheel. Then it is ready for the hackler. But as these operations pertain rather to the manufacturer than the farmer, they need not be considered at greater length here. The agricultural operations of the flax industry, as conducted in Belgium, have been described thus minutely because they illustrate, or rather emphasize, to the fullest degree, the necessity of high cultivation and skill and careful management in the production of this fiber. And while it is hardly possible that our farmers will ever take such pains with, or put so much hard labor into, the growth of this crop, the Belgian practice affords many hints which may gradually lead us into a practice essentially American, which will in time produce good results, with an economy of time, from the employment of labor-saving appliances.

Through such practice, and from the fact that our laborers are quicker than the laborers of foreign countries, and more ingenious in inventing "short cuts" in the attainment of an object, we need not be so much at the mercy of the under-paid labor of Europe, after all.

Here are some of the prices paid for labor in the flax fields of the Brabant, gleaned from an interview with a large grower and scutcher near Gembloux: workmen in field, 2.50 francs per day, not boarded (equal to 50 cents American money); women, 1.50 francs (30 cents); weeders, boys 80 centimes, and women 1.25 francs per day (16 to 25 cents); spreaders, when flax is dew-retted, boys at various wages, from 75 centimes upward, and women 1.50 francs. Seed was quoted by the 100 kilograms, at 24 francs (approximately $4.75 for 220 pounds). Belgian "blue flax," dew-retted, 80 francs per 100 kilograms (8 cents per pound), though it is estimated that these prices are too low to pay. Russian flax retted under the snow is sometimes sold in Belgium at 75 francs per 100 kilograms, or a half-cent less per pound than the above. Naturally, the production of the cheaper grades of flax is declining under this competition.

FRENCH CULTURE.

The flax culture of France is confined for the most part to the departments of Nord, Pas-de-Calais, and others contiguous in the North, Lille being the center of the industry. I visited Lille, but found nothing especially different in methods of culture and after-treatment from the practices pursued in Belgium, though I was surprised to learn that most of the flax grown in this section is transported to the River Lys, or its tributaries, for retting. Flax culture in France has suffered a considerable decline in late years, having ceased entirely in some departments, while the quantity has diminished in nearly all, save perhaps in Nord, in which the city of Lille is located. It may be stated on the authority of M. Alfred Renouard, jr., of Lille, that the preservation of the industry in Nord is owing to the proximity of the Lys, and to the great sacrifices which the agricultural people of the section impose upon themselves in transporting the product to this stream. Were this form of retting (the river-retting as practiced in Courtrai) abandoned, the culture of flax would decline at Lille as in other districts, because the sales from other systems of retting, such as the pool or dew-retting, making dark fiber, would bring such return as would only cause a loss to the producer. In other provinces the culture has fallen off two-thirds in the last thirty years, the most rapid decline being noticed since 1875.

The French flax that finds its way to the Lys is retted at Bousbecques and all along the stream at Flives, les Rauches, Hasnon, etc. It is the most expensive form of retting practiced, known as "*rouissage au ballon*"; but, on the other hand, it gives that value to the flax which makes its culture profitable. The product goes to England chiefly, a little of it being used in France for the manufacture of sewing thread.

I append prices of the different forms of flax fiber produced in France, from M. Renouard:

Dew-retted, 75 to 100 francs per 100 kilograms (about 7½ to 10 cents per pound).
Tank-retted, 100 to 150 francs per 100 kilograms (about 10 to 15 cents per pound).
River-retted, 150 to 300 francs per 100 kilograms (about 15 to 30 cents per pound).

The cultivator receives from 300 to 1,000 francs per hectare for the raw product; that is to say, approximately, $24 to $80 per acre. But the net cost of cultivation per hectare is said to be 600 francs, or in American money about $48 per acre rental included, so that the farmer grows flax at a loss if his sales fall below this figure, and at a profit if the price realized gives him more than this sum per acre. Unfortunately, there has been loss in many districts in late years, which accounts for the decline of the industry in France.

METHODS IN IRELAND.

My visit to Belfast, in the latter part of October, was mainly for the purpose of examining special flax machinery; so, little time was spent in studying the Irish methods of culture, and of handling the product after the crop is pulled.

In Ireland, as in other flax-growing countries, clean land, in good state of fertility, and with proper drainage, is required for the crop. A systematic rotation is followed, with a most thorough preparation of the land by deep ploughing, harrowing, and pulverizing (the latter especially in heavy soils), and subsequent rollings. The best of seed that can be got is sown at the rate of two bushels to the acre.[1] On heavy soils the Dutch seed is considered the most suitable, while the Riga seed is thought to answer better for the light or medium soils. The ground is kept free from weeds, the weeding being done when the flax is 4 to 7 inches high. The crop is pulled when ripe and immediately rippled, if it is desired to secure the seed, many of the Irish peasants of late years, I am informed, paying little attention to saving the seed. "Dams" or pools are employed in the retting, these being dug out in the winter, though some of the peasantry are content to use bog-holes, soft water being requisite. While the Irish peasant farmer is perhaps less careful than his Belgian confrère in pursuing this industry, it will be observed in studying the system in vogue in Ireland that success is only attained by skill and close attention to details.

Mr. John Orr Wallace gives me the following general instructions in regard to Irish flax culture:

Any good soil that will produce a good crop of wheat, oats, or barley will suffice for flax. The soil should be in good condition, but must not

[1] Says Michael Andrews, honorary secretary of the flax supply association: "Riga seed should be cleaned with a flax-sieve previous to sowing to get rid of the weed seeds; this will save expense and labor when weeding time comes round. Dutch seed being much better cleaned, will seldom require this operation."

have had manure recently applied before sowing the seed; plowing should not exceed four inches in depth. The best rotation is to sow flax after oats from lea ground; that is, grass land which has been prepared for and has produced a crop of oats, the stubble plowed in autumn, again in February or March, harrowed and rolled until the soil is thoroughly pulverized; destroy all weeds before sowing flax seed. This seed should be sown about the second week in April. When the plants are about four inches high all weeds must be pulled, the boys and girls who do the work to proceed against the wind, that the flax plants may be blown erect when the weeders have passed on.

When the straw begins to turn yellow and the foliage within six inches of the ground is drooping, pull at once. At this stage the seed in the bolls is changing to a dark green or brownish tinge. Tie the straw in small bundles and stand on end to winnow. When quite hard and dry put in stack. There is a larger and better yield of fiber when the straw is kept until the year following its growth. If fiber is required at once the seed can be rippled and the straw steeped in soft water, that is, rain-water, or, if this is not attainable, in pits of water in which vegetable matter grows, and which has been exposed to the sun's rays for a period of five or six weeks. The straw should be protected from the earth at the sides of the retting pits; place the straw in layers until the pit is quite full; stones, or planks of wood with stones on top to keep the straw entirely under the water, are laid upon the top layer of flax straw. If the temperature of the water is 80° Fahrenheit or upwards, about six days will be sufficient to ret the straw. From the fifth day examine a few straws, at different parts of the pit, several times daily, and when the fiber pulls readily and entirely off the woody core it is time to remove from the pits. Stand the sheaves on end to dry; pull the band or tying on each sheaf close to the top and spread out the root ends, so as to expose to sun and wind. When perfectly dry stack for a few weeks. This improves and mellows, or brings "nature," or a soft silky feeling to the fiber. It is now ready for the machine.

There are many interesting details regarding the Irish practice, but owing to limited space the complete account, should it be thought necessary to give it, must await the publication of the final report.

FOREIGN FLAX-CLEANING MACHINERY.

There was little of novel interest that could be classified under this head at the Paris Exposition; nor could I learn of anything of recent invention that was to be seen in successful operation in Belgium. In England and Ireland, however, there are several machines that should be mentioned in this communication, and one, the mechanical device invented by John Orr Wallace, of Belfast, that I wish especially to report upon, having spent several days in this center of the Irish linen industry, where I saw it in operation.

THE WALLACE MACHINE.

This is a flax-scutching machine. It occupies a comparatively small floor space, being 4 feet wide and but 5 long; its height is 6 feet 6 inches. It consists of an upper feed-table, on which the straw is fed to three pairs of fluted rollers, which deliver the flax downwards between five pairs of pinning tools alternating with six pairs of guide rollers. The pinning tools somewhat resemble hand-hackles, and are attached to two vertical frames, to which a horizontal to and-fro motion is imparted, and the pins interlace as the two sides approach. The fibrous material is drawn downwards by the rollers, which have an intermittent motion, and at each momentary pause the pricking pins enter the material and are rapidly withdrawn from it. By degrees this fibrous descending curtain is delivered on to an endless apron at the bottom of the machine, the woody substance falling in a crushed and semi-pulverized condition and free from fiber beneath. After the fiber has been taken from the machine it is shaken once or twice and immediately subjected to a buffer, a few revolutions of the blades, comparatively, brushing or beating out the loose bits of woody matter or "shive" that may be adhering.

Referring to the illustrations, Fig. 1 is the breaker. A is the feed table, B is the endless apron, C is the buffer, and D the hand of the operator who presents the broken and semi-cleaned fiber to the action of the wooden buffing blades. A platform should be erected in conven-

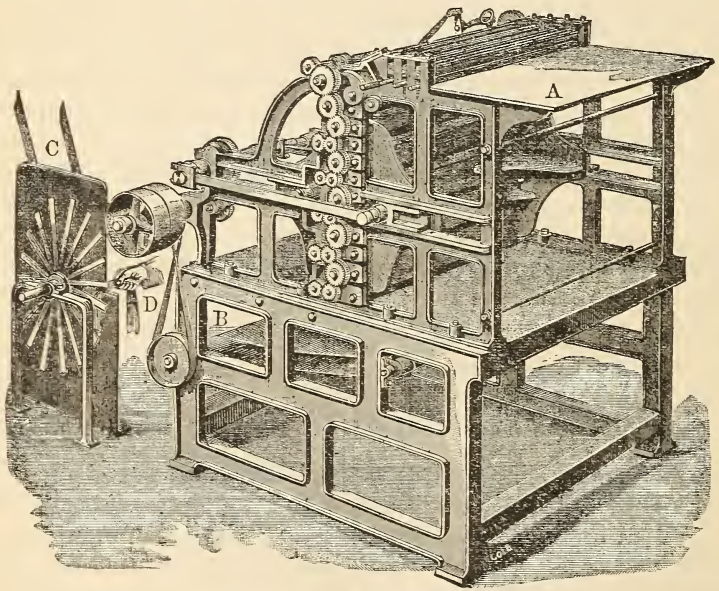

FIG. 1.—The Wallace Flax Machine.

ient position for the attendant who feeds the machine; or, when a set of three machines are employed, the platform is extended, as in Fig. 2,

one feeder being able to attend the three machines. Mr. Wallace informed me that three assistants are necessary; on the breaker or machine proper one person, a boy or a girl, to prepare the straw in bundles and one boy to feed. To attend the "buffer" one man, who takes the flat mass of disintegrated fiber as it comes from the machine and subjects it to beating blades to remove the shive. It was also explained that in the old system, as pursued at the Irish scutch mills, one attendant carries the straw to the breaker, one opens the sheaves or "beets" and hands to the man who feeds the straw into the fluted rollers, one ties the sheaves, one or two prepare the rolled straw into "strikes" or bundles for the men at scutching stocks, which are in sets of two and sometimes three men; that is, one man who puts the straw on the first stock where the blades are broader on edge and act as a further "break" on the straw; he passes the bundle to the second man, who finishes dressing, or, as is sometimes the case, passes it to a third man, and frequently these sets of men have an attendant who keeps them supplied with the "strikes" or bundles; a total of eight or ten men.

Where large quantities of flax are to be worked there will be a considerable gain by the use of two or three machines, as the two attendants who prepare the bundles for and feed the single machine can attend two or three as well. One buffer will be required for each machine, however. With a set of three machines and buffers the work can be done by—one or two to prepare bundles, according to speed of machines, one to feed, and three to buff—a total of three boys or girls and three men, or six persons. One machine will work from 10 cwt. to 20 cwt. of retted straw per day. If the straw is properly retted and of fair length the yield of clean fiber will amount to 25 per cent. Mr.

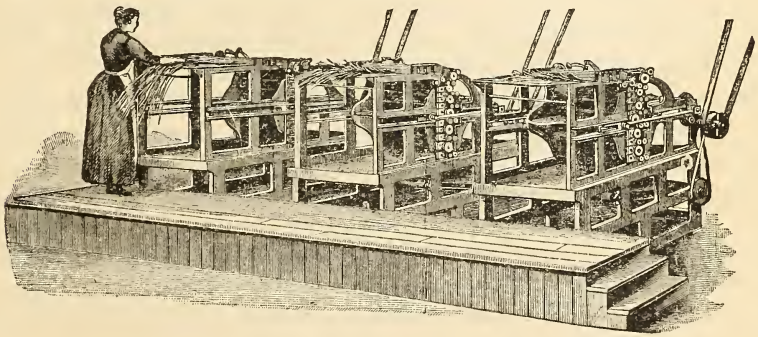

Fig. 2.—Three Wallace Machines in position.

Wallace says that good Irish has given 30 per cent. and Belgian 33 per cent., and he has obtained 24 pounds to the cwt. from straw which was so tender that no fiber could be yielded by the common system of cleaning in vogue in Ireland. He explains that the average yield under this system is but 12½ per cent. For comparison of the cost of cleaning fiber by mill-scutching and by the Wallace machine the statement was

made that the farmer pays the owner of the scutch-mill one shilling[1] per stone (14 pounds) of fiber cleaned. At this amount one-half, or a sixpence, is retained by the owner as the mill earnings, the other sixpence going to the "foreman finisher," who divides it *pro rata* among the entire staff of workmen.

From these figures and the statement regarding the capacity of one machine, the advantage in favor of the machine may readily be computed. When the cost of attendants is distributed over two or three machines the net earnings will be greater.

In a recent communication from Mr. Wallace he says:

> The proved capacity of the breaker is now such that it will keep fully occupied two buffing machines, and on good straw will enable the machines to earn from 20 to 40 shillings per day when properly fed and attended.

Two-horse power per machine is required to drive them. The price of the machine in Belfast is £250 net, payable when the machine has been tested in the foundery and found in good working order.

I witnessed the working of this machine in Belfast, various kinds of flax straw being run through it, as green or unretted, good retted, grassed and over-retted, tangled or thrashed similar to the flax straw of the Western States after the seed has been extracted, besides some other fibers. The machine worked smoothly and well, there being no waste of fiber whatever, and the cleaning was apparently accomplished evenly and thoroughly.

The unretted flax straw naturally showed the poorest results, the sample having been put through to show the adaptability of the machine for preparing a substitute for oakum, from green flax straw. The sample from over-retted straw has the appearance of a fair fiber as to length and evenness, though in color it was spotted or mottled and in places semi-bleached. A few stalks of Egyptian hemp which were run through gave a fairly good fiber.

The machine was not timed by me, and I made no attempt to demonstrate its capacity for any given length of time. The samples were all retained by me and will be preserved in the fiber collection of the Department as specimens and for future reference, though as yet I have made no microscopic or other tests in detail to learn if the flax filaments have in any way been injured by the system of pins which enters into the mechanical construction of this device. This, I have been informed, was one of the weak points of another machine, invented by Jules Cardon, and which at one time gave great promise, but which has now been abandoned. Mr. Wallace claims, however, to have obviated all danger of injury from the pins piercing the fibers themselves, and the testimony of others whose opinions were asked have been favorable to this view.

While the inventor calls it a flax-scutching machine, it is claimed to be adapted to clean hemp, flax, ramie, jute, and other fibers. I had no

[1] Practically 25 cents. The legal value of a shilling as established by the United States Treasury is 24.33 cents.

opportunity of witnessing its work on ramie stalks, but find in the Bulletin of the Royal Gardens, Kew, for November, 1888, the following reference to it, which may be introduced here:

The machine was not constructed for the special treatment of ramie. In spite of this, however, it has cleaned ramie in a fairly satisfactory manner, and the inventor claims that, with a few necessary alterations in detail, he will be able to treat the stems, either green or dry, at the rate of 1 cwt. per hour.

THE JOHNSON MACHINE.

This is another Belfast machine, but regarding which I can give little information other than gleaned from the patent specification and drawings, and from various extracts from the Irish Textile Journal and other publications, manuscript copies of which were given me. The machine was not in operation when I was in Belfast, and there was no opportunity to make a personal inspection of its workings. It is the invention of Mr. Sibbald Johnson, of Newtonards (Belfast), Ireland, who is the patentee. It may be briefly described as a rectangular horizontal frame, carrying two revolving beaters, very much like the drum of a thrashing machine. These are about 7 feet long by 2 feet in diameter, and are parallel to each other and at such a distance that their longitudinal lower blades interlock to a depth of 3 inches, like the teeth of wheels. This relative position is maintained by means of a pair of spur wheels fitted to the ends of each axle. Over the line of interlock, at an equal distance vertically and horizontally from both axles, there is what may be termed an inclined railway. Along this slides the holders in which the flax is screwed. The holder, with its beet of flax, which has been previously broken on another machine, is placed on the high end of the railway. The ends of flax are instantly caught by the beaters as they revolve downwards, and this action strips the shives and at the same time draws the holder along the incline to the other end, where it is removed. The holder is then unscrewed and the flax turned end for end, as only one-half of the beet has been cleaned, screwed up again, and a second time passed through the machine. There are several drawbacks to this feature of the machine: the danger of injury to the flax fiber from twice screwing it into the metal holders; the loss of time and the increase in number of attendants (boys) to perform the extra work; and, lastly, which is perhaps the smallest objection, the increased area of floor space required. In a trial reported the yield averaged from 20 to 25 per cent. of fiber, which dressed 62 to 70 per cent. of line.

THE DEATH FIBER COMPANY'S MACHINE.

This machine, for general fiber decortication, has attracted more or less attention for some years past, and a notice of it will not be out of place. It is the invention of W. E. Death, of Brixton, England, popularly known as the "Death and Ellwood" machine, patent bearing date July 13, 1885, improvements having been added. It claims to work well on all fibrous plants, from flax straw and hemp and ramie stalks to fleshy-leaved plants, like the *Agaves*.

It is a single-drum machine, involving the beater principle, the breakers operating upon the fiber in conjunction with a stream of water, which washes out the refuse.

The feed motion is worked as follows:

The upright handle C is for the self-acting motion to carry the leaves to or from the machine. By simply moving it backward or forwards it puts friction wheels into gear, which take the table to or from the machine. In working the holder F the levers are lifted by means of a knob at the end, and as many leaves or stems (as the case may be) as the machine will take are put across the V part in the holder and placed so that the grip on the holder may be taken near the ends of them. With ramie the point ends are cleaned first and the butt end last. After securing the stems or leaves to be cleaned the clip is put on and the lever pressed down by the knobs and the material fed into the machine by

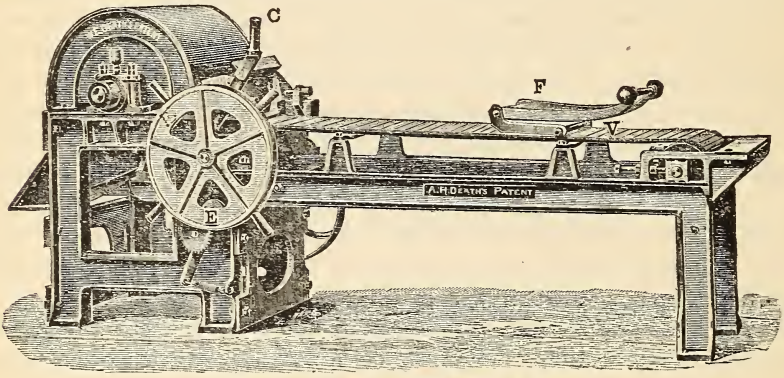

FIG. 3.—The "Death and Ellwood" Machine.

pushing the upright handle. When the holder has traveled as far as possible into the mouth-piece the handle is reversed for drawing the cleaned fiber out. The stems are then reversed in the holder and the fiber gripped in it and the ends sent forward for cleaning, as before. The wheel E is for working by hand, if desired.

The machine requires a three-horse-power engine to drive it, the velocity being 400 revolutions per minute. From 300 to 400 gallons of water per machine per hour are necessary, and this it is reckoned is attainable by a 7-foot fall through a three-fourths service pipe. The capacity of the machine is placed at 2 cwt. of dry fiber per day of ten hours. Regarding the drying of the fiber after cleaning, it is hung out on frames of bamboo poles, and when about half dry large handfuls of the fiber are whipped against a post six inches in diameter, a drawing action as the blow is given producing the same effect "as brushing and combing it and will leave it thoroughly separated when whipped a second time just before it is dry for baling." It may be noted that in field work, in the decortication of ramie, this machine has made a good record, though it has the serious fault of all ramie-cleaning machines, failure as to quantity.

THE HEMP INDUSTRY IN FRANCE.

In the latter part of September I spent a week in the hemp district of France, with a view to learn something of French methods of retting, and of the special treatment of the hemp crop in this country by means of which so white and lustrous a fiber is produced. It was my intention to go to Angers, which is the center of the industry and the headquarters of both the cordage and hemp fabric manufacture, but being able to secure all desired information in the departments of Sarthe and Ille-et-Vilaine, I did not visit Maine-et-Loire. These are the principal departments of France engaged in the industry, although Cotes-du-Nord, Morbihan, and Isère should also be mentioned.

HEMP CULTURE.

Climate has much to do with the successful cultivation of this plant, as it makes the best length of stalk, and therefore gives a greater yield of fiber, in those situations where the climate is mild and the atmosphere humid. Limestone soils or the alluvial soils, as found in the river bottoms, are most congenial to its growth, and as this portion of France is well watered by rivers or smaller streams, the cultivation is quite general along their banks. I may say that such soils in our own country have given the best results. A rotation of crops is practiced, hemp alternating with grain crops, although MM. Girardin and Du Breuil state that it is also allowed to grow continually upon the same land. Regarding this mode of cultivation, they consider that it is not contrary to the law of rotation, as by deep plowing and the annual use of an abundance of fertilizers the ground is kept sufficiently enriched for the demands which are made upon it. If the soil is not sufficiently rich in phosphates or the salts of potassium, these must be supplied by the use of lime, marl, ground bone, animal charcoal, or ashes mixed with prepared animal compost. Even hemp-cake, the leaves of the plant and the "shive" or "boon," may be returned to the land with benefit. This high fertilizing is necessary, as "the hemp absorbs the equivalent of 1,500 kilos of fertilizers per every hundred kilos of fiber obtained." The deep plowing is absolutely essential, as the hemp roots require a mellow

soil. The final plowing is done in the autumn, the land being thrown into ridges, and a couple of weeks later carefully leveled with the roller. Some farmers take this time to apply their fertilizer, or a portion of it at least, and also sow beans to form a green compost. When the beans are up the land is plowed a second time between the rows, and after making furrows to carry off the excess of water it is left until spring.

The best seed comes from Piedmont, and, as it deteriorates rapidly, it is frequently renewed. The closer the plants can be grown the better the fiber; and to this end a large quantity of seed is used. A farmer in Sarthe informed me that the usual custom was to sow 60 liters of seed to 44 ares, 40 ares being equal to an acre. This would give as the proper rate to sow about one and a half bushels to the acre, though four bushels are sometimes put in where fine fiber is desired. The sowing is done about the last of April. As in flax culture, the crop must be kept free from weeds, all injured plants must be removed, and it is the custom even to thin out the plants when growing too thickly, as is frequently the case from irregular sowing. I learned that two hundred and fifty plants to a square meter[1] of ground is considered the right average when the fiber is grown for cordage; but when produced for fabrics at least four hundred plants are allowed to grow in this area. I did not obtain full details of the manner of harvesting the crop at the farms visited, and have therefore condensed the following account of methods of harvesting from a French work[2] put into my hands by M. Grosjean, of the ministry of agriculture.

In order to obtain the best possible results in the quality of fiber, the plants should be gathered when the male stalks have shed their flowers and the stems begin to be yellow. Regarding the sex of the plant the authors state in a foot-note that—

> In many localities they give the name of male hemp to those plants which bear the fruit, and that of female hemp to those which have no fruit, a less development, and in which the vegetation is sooner arrested. This nomenclature is incorrect, as precisely the contrary (terms) should be employed.

This season of shedding the flowers comes in the west of France about the middle of July. There are two modes of gathering, dependent upon the use to which the fiber will be put. If for cordage the stalks are cut with a sharp instrument resembling a short scythe, and laid upon the ground in sheaves, where they are left to dry from one to three days. The leaves are then stripped and the stalks removed to the sheds to be assorted, placed in piles horizontally, the lower ends of the stalks being pressed firmly against a wall, so that the inequalities of their length may plainly appear. Upon each pile there is placed close to the wall a weight, to prevent deranging the stems while drawing them out in assorting. This is done just by handfuls, first the longest stems, then the medium, and then the short ones. They are

[1] A meter is about three and three eighths inches over a yard.

[2] A Treatise on Agriculture, by Messieurs Girardin and Du Breuil.

bound into sheaves, several of which are put together, forming bundles, each containing stalks of equal length. The tops of the sheaves are then cut off, and only the portion preserved that will make good fiber.

When the hemp is grown for use in spinning, that is, for fabrics, the stalks are not cut, but are pulled like flax. The operator first removes the leaves by passing his hand from top to bottom of the stalk, it being important to return the leaves to the soil where they were grown. Six to fifteen stalks are pulled at one operation, according to the ease with which they can be drawn out of the ground, and the earth shaken off. These handfuls are made into bundles about six inches in diameter; after bundling the roots and tops are cut off by means of an ax and chopping-block. The clipped stalks are then made up into larger bundles a foot or more in diameter, and are sent to be retted at once, as it is claimed that the hemp is not so white if it is dried before retting. When the seed is saved the method of procedure is as follows:

In some localities the gathering of the hemp is so managed as to secure the greatest quantity of seed possible of good quality. To this purpose the male stalks are first collected, which ripen six weeks earlier than the female stalks, the latter being given plenty of time to mature and not being gathered until their leaves and stems begin to turn yellow and the seeds to grow dark. They are tied in bunches, and of these there are made large bundles, which are placed upright, that the seed may complete its opening. The seeds are extracted by beating the stalks. This manner of operating produces less fiber, and these female plants yield fiber of inferior quality from those collected at the time of maturing of the male plants; but the harvest of seed compensates for the difference. If you take into account the expense occasioned by the double harvesting and double retting, we find that there is greater advantage in having but one harvest without reference to the seed. Dried in the air the male hemp contains an average of 26 per cent. of stripped hemp, and the female plants from 16 to 22 per cent. The stripped hemp dried in the air does not yield more than 60 to 75 per cent. of textile fiber, the remainder being foreign matter soluble in leached alkali, so that 100 parts of green hemp do not produce more than 5 to 8 parts of textile fiber.

There are two systems of retting practiced in western France, the retting in the open field, where the stalks are allowed to lie about a month, and similar to the plan followed in Kentucky, in our own country, and the water retting, which produces the best fiber. The water retting (*rouissage*) is accomplished both in pools and in running streams. The river retting seems to accomplish the best results, although taking a little longer time than the pool retting, the duration of immersion varying from five to eight days. If the weather is cold it retards the operation two or three days longer than if warm. This accounts, too, for the shorter time occupied when the immersion takes place in pools. This work is usually done in the latter part of August. The bundles of hemp are floated in the water, secured if in a running stream, and are covered with boards kept in place by stones or any weight that will keep them under. From all I could learn there is little pool retting in the Sarthe district, although public opinion is generally against river retting, on the score of its rendering the waters of the streams foul and detrimental to health as well as destroying all animal life with which

they should abound. I understand there are very stringent police regulations against the use of streams for this purpose, and as long ago as 1886, in a brochure published by M. Bary, a hemp-spinner of Le Mans, attention is called to the desirability of introducing an improved method of retting, which would accomplish all the beneficial results of retting in running water artificially, and therefore render unnecessary the polluting of streams. From M. Janvier (of the hemp-spinning establishment of Janvier, Pere et Fils et Cie, at Le Mans, successors to M. Bary) I learn that while many attempts have been made to bring about a better system, none have been successful, and, police regulations to the contrary notwithstanding, the best hemp fiber produced in the Sarthe district is still retted in the running streams. Where pool retting is followed the pools are specially constructed, dug out of the earth to the depth of a yard or more, walled up or the sides made solid, and lined and floored with cement usually, in order that the water shall remain clean and the hemp retain its color. The stalks are watched very closely after the third or fourth days, the farmer breaking and examining a few at intervals to guard against over retting, which weakens the fiber.

When sufficiently retted, whether the work is done in streams or pools, the hemp bundles are removed from the water, but first agitated to remove all waste matter that may be adhering to the stalks. They are then drained, and the bundles, opened at the bottom, are set up in conical sheaves to dry, this operation being accomplished in two or three days. Considerable of the hemp grown in the Sarthe district (I can not speak for other sections) is further dried in brick-kilns. One of these examined on a large hemp farm visited near Le Mans, and at that time in operation, may be described as a circular brick structure some 10 or 12 feet in height, resembling a smoke-house in our country. It was built on a side hill, the door opening into the chamber where the hemp was drying being on one level, the higher, while the floor to the fire-pit, at the back of the building, was on the lower level. As no evidence of a fire was observed, I infer that the fire is drawn when the right temperature has been reached, and the hemp introduced upon the grated floor to dry slowly by moderate heat. I witnessed the process of breaking hemp in the Sarthe district and brought away samples of both stalks and cleaned fiber as sent to market, as well as samples of scutched, softened, and dressed fiber prepared both for cordage manufacture and for weaving into "linen." The stalks are of creamy whiteness, as brittle as pipe-stems, and the filasse, particularly next the wood, so bright in color that no tinge of yellow is observable. A farm operator questioned told me he was able to break out 30 to 35 kilograms of fiber per day (say 60 to 75 pounds). A brake similar in principle to the old fashioned Kentucky hemp-brake is used, though lighter and smaller in the first place, produced with seven instead of five breaking-slats (arranged three opposite to four), both wood and metal being used in its construction. Double this quantity of hemp is cleaned in a day by the

negro operators in Kentucky, but it should be explained that the French operator is nicer in his manipulation of the fiber, running through a smaller quantity at one time, skillfully twisting the product into a very loose rope or "streak" of fiber, these as produced being laid most carefully side by side so that when the larger bundle of fiber is made up each has its place and can be detached from its fellows by the scutcher with hardly the disarrangement of a filament.

At a scutch-mill, where, by the way, only hand-scutching was practiced, I was shown some bales of softened fiber, and afterwards visited the establishment of a hemp-softener (*Batteur de Chanvre*), near Le Mans, to observe the process. The mill was run by water-power, the fiber being manipulated on a circular platform a couple of feet in height and perhaps eight in diameter, made of solid oak timber, the end-wood forming the surface. To a heavy spindle in the center was attached a short conical cylinder of iron weighing some 2,400 pounds. The "streaks" or ropes of fiber as received from the farmer are made up into bundles weighing perhaps 6½ pounds each, and these to the amount of 130 pounds are arranged over the surface of the circular bed or platform. The heavy iron cone is then made to revolve or travel around in a circle at a rate of speed equal to thirty-five times a minute, the softening process requiring from half an hour to one hour and a half, dependent upon the condition of the hemp under treatment. Only the finest fiber is softened, the product going to the spinning mills for the manufacture of coarse sheeting, shirting, canvas, and similar fabrics, the peasantry of Brittany, for the most part, employing hemp instead of flax in the domestic economy.

Although these details relate to the manufacturing side of the industry, rather than the agricultural, they are interesting as showing by what careful means a fiber is produced in this country (France) that will take the place of linen. While on this subject I would add that the softened hemp is not used in its whole length, but is broken (pulled apart) into three pieces on a mechanical device for the purpose found in all hemp-mills (and even in our own country). The bottom third is the best, and is kept separate for use in the finest numbers of yarn.

How much of the French methods of hemp culture and manipulation might be adopted in America, with advantage, remains to be determined. Two points however may be noted: That a more careful practice with more thorough methods of handling throughout will be necessary to improve the fiber to that point that will make it available for the higher grades of manufacture, and also that a better system of retting must be followed, though the contamination of streams in the rural districts of the United States will hardly be allowed by the residents of any section of the country. American ingenuity must devise a plan which will be distinctly American, and both practical and economical, and one that will not at the same time tend to make the cultivation of this crop exhaustive to the soil.

THE RAMIE MACHINE TRIALS.

Probably no one fiber interest represented in the Paris Exposition of 1889 attracted more attention than ramie, nearly every country of any prominence which took part in the exposition either sending specimens of fiber to show the result of experiments or progress of its own culture, or commissioning representatives to ascertain the latest facts regarding it. The United States Department of Agriculture made a small display of ramie illustrating the simple fact that the plant can be grown successfully in the United States, and produce a filasse of good quality.

During my residence in Paris, and while connected with the American Commission to the Exposition of 1889, I studied as far as possible the recent progress that has been made towards establishing the ramie industry, and especially in relation to machines or processes for the decortication or cleaning of the fiber. I can only place on record here, however, the result of the official tests of the ramie machines, which took place September 23, 24, and 25, on the grounds of the exposition, with brief descriptions of these machines and such other general information as may be deemed important.

Six machines and one chemical process were entered, as follows:

The Armand-Barbier machine (E. Armand, 46 Boulevard Richard-Lenoir, Paris); two forms of the Favier machine, one for green and one for dry stalks, exhibited by the "Société la Ramie Française," (P. A. Favier, 14 Rue St. Fiacre, Paris); two forms, a large and small, of the De Landtsheer machine (Norbert de Landtsheer, 2 Place des Batignolles, Paris), and the machine exhibited by Felicien Michotte (of 43 Rue de Saintonge, Paris). The process was that of Ch. Crozat de Fleury et A. Moriceau (7 Rue de Londres and 4 Faubourg Poissonniére, Paris), and was for treatment of the stems in green condition.

THE FAVIER MACHINE.

The first trial was that of the smaller of the machines exhibited by the French Ramie Association, adapted for work upon green stalks. Ten kilograms of stripped stalks (equal to about 22 pounds) were put through the machine in four minutes and thirty seconds, which included one or two brief stoppages. The net product of well cleaned wet ribbons weighed 2.82 kilograms, equal to almost 6¼ pounds.

In the second test 60 kilograms of stalks with leaves were used (about 123 pounds), divided into lots of 10 and 50 kilograms respectively.

The first lot ran through in two and a half minutes, the second in fifteen minutes and a half, the difference in time being due to some of the ribbons fouling the last pair of rollers, necessitating a stoppage. The product of the decortication was 18.1 kilograms, equal to about 40 pounds of wet ribbons nicely cleaned.

On the afternoon of the 24th of September a test was made with the Favier machine on dry ramie with the following results: Thirty kilograms of stalks ran through the machine in thirty-three minutes, there being several stops. (The actual time, that is, deducting time lost in stoppages, was twenty-seven minutes forty seconds.) The yield of dry ribbons was 7.70 kilograms, or very nearly 17 pounds. A later trial of this machine on five kilograms of ramie stalks dried in a furnace at 30 centigrade (which makes softer fiber) ran through in three minutes and sixteen seconds actual time. The product was 21 per cent. of fiber, as claimed by M. Favier, though the record of actual weight can not be given. At these tests two men were employed, although a feeder and an assistant and a receiver and an assistant make up the usual complement of attendants or operators required.

Some days before the official trials I had an opportunity of examining the larger machine privately, and seeing its work for dry ramie stalks grown in several countries, including some secured by myself from two localities in Texas and sent to Paris with the United States agricultural exhibits. Without considering the capacity of the machine, that is, the amount of fiber it will turn out in a given time, it must be admitted that on dry ramie it does its work more perfectly than any decorticating machine I have ever seen. Some of the filasse from Spanish-grown stalks was almost nice enough to work up into twine or cordage or similar coarse manufactures without further manipulation. It may be remarked, however, that ramie is too valuable a fiber to be employed in cordage or the coarser manufactures. There is little or no waste by this machine; the chief objection that may be urged against it is its very complicated mechanism, adapting it more for use in a central factory, where it would be attended by experienced operators, than for employment on the farm to be run by ordinary farm hands. Its cost, too, makes it at once a machine for the central factory and not for the farm. The smaller machine, adapted for work on green stalks, costs 2,500 francs, and the dry stalk-machine, making a complete decortication, 5,000 francs; practically $500 and $1,000 respectively. Either machine requires a force of three-fourths horse-power, the refuse of decortication supplying more fuel than the boiler requires. In fact the refuse of one machine is sufficient to furnish power for four. As has been stated, while two operators can run the machine, it is adapted for four persons; but as the work is light, it is claimed that it can be performed by two women and two children. It should be remarked that women are frequently employed in such occupation in Europe where only men would be employed

in this country. In a personal communication to the writer M. Favier claims the following as the capacity of this machine:

With two workmen, employed ten hours, according to the degree of decortication required, the machine will produce from 120 to 180 kilograms of decorticated fiber; with four workmen, 240 to 360. The quantity of dry stalks passed through the machine "with one workman at the point of introduction is 600 kilograms;" and with "two workmen, of course double that quantity, or 2,640 pounds." Owing to the peculiar construction of this machine the stalks are fed one at a time, the feed entrance being reached between a number of metal pins one-fourth inch thick, 4 inches long, and placed at proper intervals apart to admit easily a large stalk of ramie. These were evidently guides. When the stalks with leaves were fed, I supposed many of these would be stripped off by this attachment, but such was not the case. The machine may be described as follows:

The machine (as illustrated by Fig. 4) consists of two parts, which are shown combined, but which may be used separately if desired. The

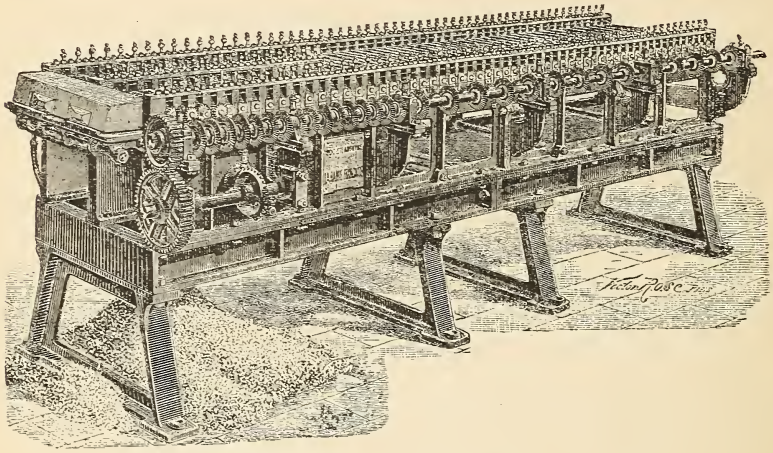

FIG. 4.—The Favier Ramie Machine.

first slits the stem or stalk either entirely through or nearly through, flattening it into two bands. As the stem is fed by hand two vertical feed-rollers receive it and pass it through a tube provided with the slitting-knife, and so shaped that the slit is opened out. These parts are hidden from view in the illustration. Flattening-rollers next receive the stems, crushing them, the wood and bark however maintaining their layer-like positions. Here the stems pass into the second machine. Rollers with wide grooves seize these ribbons or layers of wood and bark, breaking the wood into short pieces a quarter of an inch in length, which drop away, leaving the bark intact. This is then subjected to a series of rubbing and beating rollers, which manipulate the ribbon on both sides, removing the pellicle and disintegrating the fiber, which

is produced entire, cleaned and straight, within perhaps two seconds from the time the stem leaves the attendant's hands.

Since the trials the following letter has been received from M. Favier, which explains itself:

PARIS, *October* 27, 1889.

DEAR SIR: I have received your favor of 16th instant, and I had delivered already to Mr. Amory Austin some samples of ramie for you. To-day I deliver samples of fiber proceeding from my machine working the stalks in the dry state, and from my new machine working green stalks. Since the trials we have made new experiments, and here is the result:

In twelve minutes we passed through the machine 100 kilograms of green stalks, which correspond to 500 kilograms an hour, and 5,000 for ten hours, with but two workmen. With four workmen, it is not exaggerating to say that we can operate upon 7,500 kilograms.

This result will be probably interesting to your Government.

Entirely at your service.

I remain, dear sir, yours truly,

(Signed.) A. FAVIER,

Le Directeur de la Ramie Francaise.

Mr. CHARLES RICHARDS DODGE,

Special Agent, Fiber Investigations.

THE ARMAND-BARBIER MACHINE.

In the first trial with this machine 10 kilograms of stripped stalks were decorticated in six minutes, giving 1.30 kilograms of wet ribbons, or about $2\frac{7}{8}$ pounds of ribbons from 22 pounds of stalks. In the second trial 24 kilograms of stems with leaves were decorticated in ten minutes and thirty seconds, giving 1.20 kilograms of wet ribbons, or about $2\frac{3}{8}$ pounds of fiber from about $62\frac{4}{5}$ pounds of stalks and leaves. In the trial of dry stalks, 12 kilograms of stalks were passed through the machine in thirty minutes, yielding 2.20 kilograms, approximately $4\frac{7}{8}$ pounds of ribbons from 26.75 pounds of dry stalks.

The ribbons produced were not of the best quality, and the reverse action of the machine, that is running the fiber part way through, then withdrawing it and presenting the other end, makes it very slow in operation. The machine is quite simple, however, though to all intents and purposes is the same in principle of construction as the Landtsheer machine, considered a little further on. The dry ribbons produced are broad and flat, and none of the outer pellicle is removed. The refuse woody material comes away in large pieces, and a considerable percentage of the fiber itself is whipped or torn off, and falls with the refuse of decortication. This machine occupies but a small floor space and weighs about 1,375 pounds. Its cost is 1,200 francs. No other information was obtained concerning it.

THE MICHOTTE MACHINE.

The trials of this machine were the most unsatisfactory of any in the contest, the quality of decorticated fiber being very poor, as it was filled with unseparated fragments of wood and the ribbons much broken and

injured. In the trial with stalks retaining their leaves, the machine clogged frequently, the cylinders becoming badly fouled. There were no tests with dry ramie. The record of the first trial is as follows: Green stalks 7 kilograms, equal to $15\frac{2}{5}$ pounds; time of the decortication, one minute and thirty seconds; product 1 kilogram, equal to $2\frac{1}{5}$ pounds of semi-cleaned ribbons. In the second trial 17.4 kilograms (38.28 pounds) of green stems with leaves were decorticated in two and one-half minutes, the result giving 6 kilograms (13.2 pounds) of ribbons. There were no trials on dry stalks at this time.

This machine is composed of four crushing rollers of large size, having a special form of fluting. These rollers are followed by a steel breaker with elastic beaters working in connection with another breaker of similar form. The large rollers first crushed the stems and then

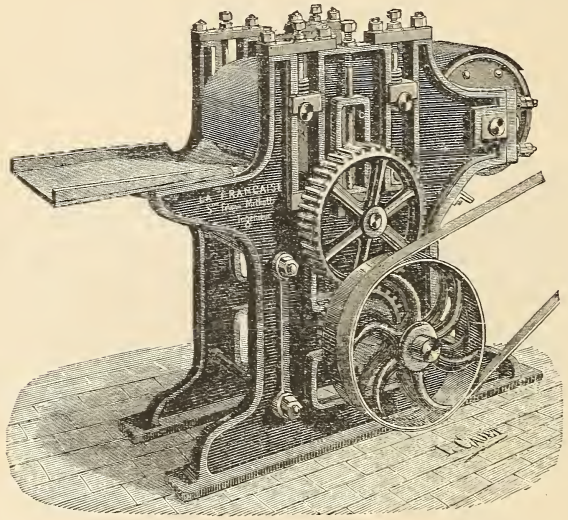

FIG. 5.—The Michotte Ramie Machine.

passed them to the beaters which were intended to free them from wood and fiber. I have specimens of the work of the machine on stalks of dry ramie, obtained from a private trial, and while better than the specimens of the green decortication, they are nevertheless poor. The price of the machine, made in two types, has been placed at 3,800 and 4,000 francs.

THE LANDTSHEER MACHINES.

In the first trials of the large machine 36 kilograms of stripped green stems were decorticated in two minutes and thirty-five seconds, the yield being 10 kilograms of wet ribbons (or about 22 pounds). This was in two lots of 10 kilograms without leaves and 26 kilograms with the leaves. At another trial, 46 kilograms of green stalks with leaves (two hundred

stems) were cleaned in eleven and one-half minutes, giving 15 kilograms of wet ribbons, filled with fragments of woody matter, chips, and even short sections of stems. This was then passed through the small machine in six and a half minutes, the 15 kilograms of partially cleaned ribbons giving 10.5 kilograms, showing a shrinkage of almost five kilograms weight by the second operation, or 30 per cent. Another trial of the small machine with 24.4 kilograms of green stalks with leaves, gave in ten minutes 6.50 kilograms of ribbons. This was at the rate of 14.32 pounds of wet ribbons from 53.79 pounds green stalks.

It was noticed that the larger machine did not decorticate well the last few inches of the stalk when fed in tops first, pieces of almost unbroken wood an inch or more in length loosely adhering to the ribbons. When fed butts first better results were obtained, though the ribbons invariably showed a percentage of semi-loose chips and litter. These machines have also the reverse action described in the Barbier machine, though in the trials with the large machine the action was continuous.

In the trial with dry stalks, without changing or cleaning the large machine, 30 kilograms were decorticated in twenty-one minutes, giving

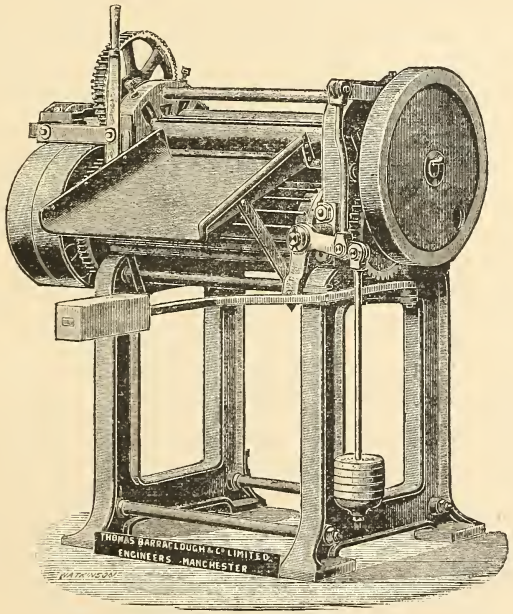

FIG. 6.—The Landtsheer Ramie Machine.

10 kilograms of flat ribbons, the outer pellicle not being removed. Two men were required to run each machine.

The Landtsheer machine may be described as composed of three cylinders tangent to another central cylinder. The feeding cylinder is

arranged with spiral grooves to regulate the feeding of the ramie stalks. The crushing cylinders are alternately smooth and grooved longitudinally in such manner that when working together the grooved part of one bearing upon the smooth parts of the other crushes the stalks. These cylinders are held in place by springs. After leaving the crushing cylinders the broken stalk passes between a pair of beaters, each supplied with sixteen winglets geared in such manner that they lightly interlock, this action brushing off or removing the woody matter and the bark. A force of one and a half to two horse power is required to drive the machine.

THE FLEURY-MORICEAU PROCESS.

This seemed to be simply immersion of a quantity of ramie stalks, either dry or green, in a rectangular galvanized iron tank of boiling water set upon masonry to admit of fire beneath to continue the boiling for a certain time, varying from five to fifteen minutes. The stripping of the ribbons was performed by hand by two men with occasional outside assistance. Eighteen kilograms of green stalks were used in the trial, the boiling occupying ten minutes and the decorticating thirty-six minutes, the result being 5 kilograms of good ribbons. The process is too laborious to be used in any country where living wages are paid, though the inventors claim that the ribbons can be produced, baled for shipment, for 8 to 10 centimes per kilogram, or about $21 per ton.

Here is the summary of the ramie machine trials of 1889, reduced to tabular form:

TABLE I.—*Summary of the trials.*

	Machine.	Weight of stalks.	Condition of the stalks.	Time.		Weight of fiber.
		Kilos.		′	″	*Kilos.*
1	Favier, small	10	Green, without leaves	4	30	2.82
2	do	60	Green, with leaves	18		18.1
3	Favier, large	30	Dry stalks	33		7.70
4	Armand-Barbier	10	Green, without leaves	6		1.30
5	do	24	Green, with leaves	10	30	1.20
6	do	12	Dry stalks	30		2.20
7	Michotte	7	Green, without leaves	1	30	1
8	do	17.4	Green, with leaves	2	30	6
9	Landtsheer, large	36	Green, without leaves	2	35	10
10	do	46	Green, with leaves	11	30	15
11	Landtsheer, small	(*)		6	30	10.5
12	do	24.4	Green, with leaves	10		6.5
13	Landtsheer, large	30	Dry stalks	21		10
14	Fleury-Moriceau process	18	Green, without leaves	46		5.6

* The 15 kilograms of ribbons from preceding.

As a showing of the capacity of these machines for a day's work of ten hours, I subjoin a table prepared by Dr. Morris and published in the Kew Bulletin for November, 1889. The trials are numbered to correspond with the arrangement in my own table. The column relating to condition of the stalks is omitted.

TABLE II.

	Machine.	Weight of stalks.	Time.	Weight of fiber (wet).	Estimate per day.*
		Kilos.	′ ″	*Kilos.*	*Pounds.*
1	Favier, small	10	40 30	2.82	276
2	....do	60.35	18	18.1	443
3					
4	Armand-Barbier	10	6	1.3	96
5	....do	26	10 30	1.2	50
6					
7	Michotte	7	1 30	1	
8	....do	17.4	2 30	6	
9	Landtsheer, large	36	2 30	10	†1,763
10	....do	45	11 30	15	575
11					
12	Landtsheer, small	24.4	10	6.5	287
13					
14	Fleury-Moriceau	18	46	5.6	161

* Estimated quantity in pounds of dry ribbons producible in a day of ten hours. In preparing this estimate the wet ribbons are calculated to yield one-third of their weight of dry ribbons, and the kilogram is taken as equivalent to 2.204 pounds avoirdupois.

† This large yield of ribbons must be reduced about 20 per cent. on account of the pith and wood ightly adhering to them.

I also append another table, from the same source, comparing results of the trials of 1889 with those of 1888.

TABLE III.

Machine.	Quantity of dry ribbons producible in a day of ten hours, (pounds avoirdupois), working on green stems.	
	1888.	1889.
De Landtsheer:		
Large machine	.....	*1,763
Small machine	120	287
Barbier	71	96
Favier No. 1	.....	443
Fleury-Moriceau	.....	161

*See second note in table above.

Comparing the results of the French ramie-machine trials of 1889 with those of the previous year, it is evident that some progress has been made, and the prospect of putting the ramie industry upon its feet seems brighter than at any previous time in the history of the experiments with this fiber. The record of progress of the industry in general, with interesting statements relating to our own country, will be found in its appropriate place in the second part of this report.

PART II.

FIBER PRODUCTION IN AMERICA.

FIBER PRODUCTION IN AMERICA.

FLAX CULTURE IN THE UNITED STATES.

Regarding this industry, were we to accept as final the statements of a few of the American flax-spinners who use fine line flax in their manufactures, we would be obliged to say that, from the agricultural standpoint, a flax industry not only does not exist in the United States, but, following the arguments presented in favor of admitting raw flax free of duty, never could be established. Even cleverly selected official figures from, and statements of experts in, more recent Government publications on the subject, have been reproduced and presented as arguments to support this view.

It is proper, at the very outset, to look the fact squarely in the face, that we produce at present very little if any flax that would compete with the fine line flax[1] imported for manufacture into the higher numbers of yarns. It is equally true that our farmers do not now, nor have they in many years, if ever, followed the careful methods of culture and after-treatment in harvesting and retting of the straw that are practiced in the prominent flax growing countries of Europe; nor could they, at once, acquire the skill of these foreign flax growers (and grandchildren of flax growers), were they to adopt their methods, with ample remuneration, in this the present year of our Lord.

And this is the full text of the arguments put forth by those who have no wish to see a flax fiber industry established in the United States, and all that can be found in any publication of the Department of Agriculture to support the arguments they present. As there are degrees in skill in the growing of flax fiber, so are there grades in manufacture, and to assume that because we can not, at once, produce a quality of fiber fit for table damask or linen thread, we can not produce a quality of fiber fit for any form of manufacture from flax, is to create an impression that is false and misleading. But I will go a step farther, bearing in mind the vast extent of our country, its great diversity of soil and climate, and the fact that it is inhabited by a people

[1] As this report is going through the press a fine sample of a car-load lot of Wisconsin flax has been received from an Eastern manufacturer, who says, in concluding the letter accompanying, "and this flax is good enough for even fine linens."

noted for intelligence, energy, and inventive genius, having in its citizenship those who have successfully grown flax, not only in the United States, but in the old world, to assert that, with proper encouragement, we can not in time produce fine flax, is to compromise American agriculture and the millions who are following it as an occupation.

In part I of this report I have endeavored to present detailed statements showing the careful culture and skillful manipulation necessary to produce fine fiber. These are recorded, not so much with the idea that our farmers will adopt them wholly, as to supply hints for a practice adapted to American agriculture which will result in improved methods over the practices at present followed, to the end of producing a fiber that, if not fit for fine linen manufacture, will at least be fit for some form of manufacture sufficient to create a demand for the product. Reference has been made to Government publications, i. e., the reports of the Department of Agriculture. A perusal of these documents for a period of forty years, and in connection with the census volumes, gives abundant evidence that flax cultivation for fiber has been a recognized American industry. In a flax and hemp inquiry,[1] made by the Department of Agriculture ten years ago or more, many interesting statements were received regarding the cultivation of flax in this country during the first half century of the Republic, which were not recorded, being chiefly historical rather than personal experiences, showing how well established was the industry. Not only were references made to that early period in the nation's history, when the flax-wheel was as common in the household as is the sewing-machine in our generation, but it was shown that at a later period good flax fiber was produced in many portions of the United States, and at various times quite extensively. Reference was made to the New York and New England flax of sixty to seventy years ago, which is described as strong and flexible, though not always as clean as it should have been, and sometimes uneven in quality. The history of the flax culture from that time down to within a score of years of the present time is a history of flax fiber production in varying quantities, the most of it being good staple flax.

As late as ten years ago a Massachusetts manufacturer of crash and similar grades of linen goods, who used flax from Russia, from Canada, and from New York State at his mills, stated in a communication to the writer that he made a difference of one-half cent in favor of American flax when properly dressed. Another manufacturer, in considering the quality of American flax, said that it was about equal to third crown Archangel, and also stated that when American flax was abundant and the fiber was satisfactory there was less call for the grade of Russian, with which it competed.

And since the 1st of January of the present year a number of prominent manufacturers in various parts of the country have expressed the opinion that with a better system of cultivation and handling of the

[1] See Annual Report for the Department of Agriculture for 1879, pages 565–611.

flax crop of the United States, as now grown for seed, the fiber could be utilized in coarser manufactures, though a higher rate of duty on these manufactures is desired. And in several instances their statements were accompanied by samples of the flax fiber.

The flax producer who is asked to improve his product, as he scans these pages, may well demand why he too may not be encouraged in the adoption of a better practice by a higher rate of duty on the raw material. It is a reasonable request, despite the objection urged by some manufacturers that an immediate supply of the home-grown raw product to meet the existing demand could not be assured, and that it would still be necessary to rely upon the foreign market. The answer to this argument is that without making a beginning there can never be an agricultural flax industry in the United States. There are many experienced flax growers in the United States who are now ready to make a beginning, but who hesitate to embark in flax production on the present narrow margin of profit. The manufacturers ask an increase from 35 per cent. ad valorem to 50 per cent. The present duty on the raw material is about 7 per cent. In view of the wide difference in the tariff already existing between the manufactured article and the raw material, it would seem a very modest demand on the part of the flax and hemp growers to ask for one-half the rate of advance demanded by the manufacturers. This would be equivalent to doubling the present tariff on the raw material; and even then the grower's protection would not amount to more than 15 per cent.

To go back a quarter of a century or more to the period of the war, it is not so long ago that the labors of the flax and hemp commission, in the interest of flax culture in the United States at that time, are entirely forgotten. But allow me to give the reference in the words of a little work on "Flax Culture,"[1] recently published, because it states the matter so truthfully:

> In 1863 Congress appropriated $20,000 for an investigation to test the practicability of cultivating and preparing flax or hemp as a substitute for cotton. A commission was appointed which examined the whole subject thoroughly, and made a most elaborate report to Congress. These efforts of the General Government, combined with the high price of flax, stimulated the growth of flax, and the amount of flax fiber produced was large.

Here is the next chapter: In 1866 the area under cultivation in flax was something over 50,000 acres. In the short period between 1866 and 1869 it was almost doubled. In 1866 about three-sixteenths of the cotton crop was covered with flax bagging, and in 1869 three-fourths of the entire crop was baled with flax fiber, the remaining one-fourth being covered with bagging made from other fibers. This meant an increase in four years from 12,000,000 pounds of fiber to 80,000,000 pounds. The cotton crop of 1870 was 4,347,000 bales, this enormous production taxing the capacity of every bagging-mill in the country to

[1] By E. A. Whitman, A. M., and J. R. Leeson, Boston, 1888.

its utmost. Even with the opening of the new factories large orders for jute bagging were placed abroad to make good the short supply which seemed inevitable. Then followed the year 1871, a year of the bitterest antagonism between manufacturers and the holders of raw material. It was necessary to effect sales, and prices of both fiber and bagging were forced down. Then followed the tariff legislation of 1872, which removed the duty on jute butts, and mill after mill throughout the West was forced to suspend operations, and they never resumed.[1] Here was a very good beginning of a flax fiber industry in the United States, that with a very little encouragement at the time would have been developed into something better than bagging-tow production. The people interested in the industry were not only enthusiastic but sanguine. So sure were they that the flax culture was an established thing that in some instances machinery was procured for the manufacture of crash and the coarser goods and located in the centers of flax fiber production.

I have before me a communication, only recently received, wherein is detailed the history of one of these unfortunate enterprises, the manufacturer having lost $18,000 through the collapse. His machinery had just been imported from Belfast, and a Belfast spinner was employed to direct the operations. I am aware that there was a duty of $20 per ton upon raw flax fiber at this time, but as the men who were seeking to extend their business in this manner derived their income from bagging manufacture chiefly, it is to be seen that the new industry could but fail when the old one collapsed. The act of 1870 placed a duty of $20 on a product worth at that time from $250 to $300 per ton. This, when hemp had, up to a year or two, been protected at the rate of $40 per ton. I can only touch thus briefly upon these interesting points in the limited space of the present report; but more detailed statements accompanied with tables of explanatory figures can be made at a future time if desired. Enough to show that even with the slight encouragement this industry has had in the past, the growing of flax for fiber in the United States has been a source of revenue to the American farmer.

But it may be urged that growing flax for bagging is a pretty low order of fiber cultivation. As I have said, there must always be a beginning. When our farmers have learned how to produce fiber from flax straw that is good enough and cheap enough for bagging or binder twine, they are on the sure road towards the production of a better quality of the raw material for employment in a higher grade of manufacture. From the experience gained by a very few years of practice with better methods of culture and treatment, and with the assurance of a market for their product at fairly remunerative prices, it would be but a step to the production of a quality of fiber fit for the coarse linens, and

[1] A former manufacturer of flax bagging informs me that the industry also suffered injury through the careless use by a few bagging producers of a bad quality of fiber produced from green or unretted flax.

to that promising extent the flax industry would be established. Good samples of fiber from old flax-growers in several of the Western States, and even from Texas and California, have been received by the Department recently, one especially noteworthy coming from a former Belgian flax-grower, now a resident of Wisconsin, who is sending flax in quantity to the Eastern market. An Illinois farmer, within a few weeks, has sent to the Department a sample of flax fiber that is strong, though coarse, asking if it is not good enough for binder twine. He quotes prices paid for binder twine in the past two seasons, and makes the statement that the farmers in his section are ready to put up a flax binder-twine mill if the flax produced on their farms and grown for seed can be utilized in the manufacture. He says:

> This flax was cut short so as to save only the seed, but if it was known that we could use it for binder twine we could cut it within 2 inches from the ground so as to give longer fiber; it could be bound and only the heads of the bundle thrashed and the straw kept whole.

As a relief from high prices it is proposed by the manufacturers of binder twine from sisal, manila, and jute, to place these fibers on the free list, because they are not produced by the American farmer, yet binder twine can be manufactured from both hemp and flax, and every pound of it grown in our own country.

"Yes, but at the expense of the grain-grower," suggests the advocate of free sisal and manila.

Well, who are the grain-growers? In foreign countries the grain-growers are the flax-producers, for in the regions where the best flax is cultivated, as already shown, rotation of crops is positively essential to success. In a nine years' rotation in Belgium there are often five crops of grain to one of flax on the same piece of land, which means, as flax is grown every year on some one section of the farm, five other sections must be devoted to wheat, oats, barley, or rye, or perhaps all four.

But even the argument that our farmers can not compete with foreign fiber-producers in an open market is not a conclusive one, for, having made a beginning, the effect of competition at home would be to gradually reduce the cost of production through the acquirement of knowledge and skill and the American tendency to turn "short corners." The statement made in another part of this report that a French hemp-breaker produces or cleans but 75 pounds of fiber in a day against the Kentucky negro's 150 pounds is an illustration of the point I would make. The difference in the two products is something, it is true, but, after all, the advantage is largely on the side of the American workman. And right here the suggestion is in place that the future of the fiber-producing industries of America depends largely (after reaching a certain point) upon the invention of labor-saving machinery, as well as the adaptation of present machinery to new uses, to take the place, in a measure, of the costly practice and tedious methods followed abroad.

Given the advantage of labor-saving and time-saving appliances, with

the increase of man-power, as represented by the greater development of energy and nervous force in the American laborer, the difference in the cost of labor here and abroad would be more nearly equalized. In the production of wheat to feed Europeans we employ the best labor-saving machinery that the world can produce, and it is of American invention and manufacture. What we can do for wheat-growing we can do for flax culture when there is an incentive for the effort.

It has been stated that when we had the beginning of a flax industry, and the fiber was produced in New England and the Middle States, that there were no standards; that American flax was rarely prepared twice alike, and as there was no unity either between growers or among dealers, a manufacturer seldom knew what he was buying without testing samples of the product offered; yet this is a matter that in a very short time would regulate itself, or as soon as there was a steady production, as an official inspection and grading would be established by the buyers and sellers, just as the flax-seed product is now inspected by the Board of Trade of Chicago. The farmers would soon learn the requirements of the trade, and with experience would be able to produce a certain quantity of fiber, just as a certain quality of butter is regularly produced on dairy farms where systematic methods are pursued.

PRESENT STATUS OF THE INDUSTRY.

What of the flax culture of the present? In general terms the situation may be briefly stated thus: Grown almost wholly for seed, the straw, of inferior quality, when used at all, going to the tow-mills or the paper-mills, and worth from $1 to $8 a ton, the average in different sections being not more than $2.50 to $4. In the older States, the area under present cultivation is very small and steadily decreasing; in the newer States, or States where agriculture is being pushed steadily westward from year to year, the area under cultivation either just holds its own one season with another, or is increasing.

In all the newer States it is the common practice to grow on "first breaking," or land plowed from the prairie sod, no manures being used, or rarely used. On cultivated land it is the custom to grow after corn, grain, or clover, and it is almost the rule to follow with a grain crop of some sort, wheat and oats being most commonly cultivated. Corn is also grown, and sometimes grasses and clover or potatoes. In such cases the ground is prepared as for a wheat crop, barn-yard manures being applied; in some rare instances, bone or other fertilizer is spread after seeding, and the soil is brought to a fine state of tilth by harrowing. It seems to be generally understood that a fine mellow soil is necessary for the success of the crop; one or more, sometimes three plowings are given, and the earth pulverized as thoroughly as possible. The seed is obtained at the oil mills, at the local stores, and imported, some Russian seed ("Large Russian") being sown in the new States. It is either drilled or sown broadcast, the latter being the almost universal custom.

There is no cultivation given the crop while growing, and when the seed is ripe the straw is cut with the reaper, the knives set high, and the "self-raker" employed. The straw is run through an ordinary thrashing-machine, which breaks it up worse than hay. When not sold for fiber it is fed to sheep and cattle, used to thatch sheds and for bedding for stock or for packing ice; it is rotted for manure, wasted, or even burned to get rid of it. Regarding its use in feeding stock, when in Belfast, my attention was called by Secretary Morton, of the Flax Supply Association, to a statement in one of the Department reports to the effect that flax straw could be fed to cattle. Mr. Morton took exception to the statement, and criticised its having been made in an official publication, urging that the fiber in the straw was more than likely to cause the death of any animal eating it in quantity. I would like to inform our foreign friends that the practice of feeding flax straw to sheep and cattle is common in the West; that were the question asked of a thousand flax-growing farmers, fully four hundred would answer "yes." While this is a fact, the practice can not be condemned too strongly.

As to growing for fiber, there are small areas which produce a fair quality for coarse uses, though the product is extremely small. And what may appear as a novel statement is the fact that in the year 1889, in Virginia, good home-spun linen was made for family use, the straw being carefully grown on thoroughly prepared soil, well cultivated, and the product well handled and retted, and the seed was beaten out by hand and sold at $1 a bushel.

In a very few localities flax straw brings somewhat higher prices than those I have quoted. The little sold in New York ranges from $7 to $25 per ton, the latter price being quoted in Schenectady County. In Ohio the range is $2 to $15 per ton, the latter figure having been paid recently in Shelby County, and in other counties from that price down. Ohio formerly manufactured large quantities of flax bagging, and on the authority of the Department State agent for Ohio, the statement is made that a little flax bagging is still manufactured there. The following figures ot acreage for three years are from the Flax-Seed Inspection Report of 1889, published by the Chicago Board of Trade:

1887.

State.	Acres.	Bushels.	Value.
Indiana	14,872	107,208	$107,208
Illinois	10,184	81,472	81,472
Missouri	45,000	395,000	375,250
Kansas	142,577	1,400,741	1,190,630
Nebraska	150,922	1,220,006	1,098,005
Iowa	265,000	2,186,250	2,055,075
Dakota	488,993	3,910,944	3,519,849
Minnesota	167,264	1,318,121	1,252,214
Total	1,284,812	10,619,742	9,679,703

1888.

Indiana	13,949	101,693	101,693
Illinois	6,181	49,448	54,394
Missouri	43,000	387,000	387,000
Kansas	162,655	1,340,222	1,206,200
Nebraska	67,626	710,371	639,334
Iowa	251,750	2,265,750	2,514,982
Dakota	370,406	2,963,247	2,666,922
Minnesota	166,184	1,661,840	1,661,840
Total	1,081,751	9,479,571	9,232,365

1889.

Indiana	12,860	102,860	113,146
Illinois	5,556	44,448	48,892
Missouri	40,000	360,000	396,000
Kansas	113,329	1,019,961	1,019,961
Nebraska	81,151	887,964	976,760
Iowa	246,535	2,465,350	2,761,192
Dakota	403,314	3,288,115	1,452,520
Minnesota	157,540	1,647,622	1,812,384
Total	1,060,285	9,816,320	10,580,855

Ohio, which is omitted, had an area of 16,134 acres under cultivation last season.

A great deal is said by the farmers in this country about flax being an exhaustive crop. That it is not an exhaustive crop is abundantly proved by repeated chemical tests in this country and Europe, showing that flax takes less inorganic matter from the soil, per acre, than wheat, oats, barley, or tobacco. It must naturally prove a very exhausting crop as the majority of our farmers grow it—for seed production, without rotation, and with little or no manuring, selling the seed to the oil manufacturers, burning or wasting the straw, and returning nothing to the ground. It is not found an exhaustive crop in Europe, because its cultivation is conducted on common-sense principles. As the fiber is composed of elements taken almost wholly from the atmosphere, while the mineral elements of the soil are found in the waste material of the plant, the only rational course to pursue suggests itself.

CULTIVATION.

For the guidance of those who may wish to try the experiment of growing flax for fiber the present season a few brief hints are given. Much depends upon the selection of the soil, a moist, deep, strong loam upon upland giving the best results. Barley lands in the Middle States, and new prairie lands or old turf in the Western States are frequently chosen. On the contrary, a soil full of the seeds of weeds is not to be thought of under any consideration. Some New York flax-growers incline to a heavy clay loam for the production of fiber and seed, though the choice of a wet soil will be fatal to success.

Flax culture in Russia is carried on upon the vast plains in the interior subject to annual overflow from the rivers. As we have seen, rotation of crops is an element of success in all foreign countries where flax

is produced. By studying the practices abroad the American flax-grower can determine what will be best in his own practice. Fall plowing is desirable in our own country, with a second plowing in the spring as early as possible. Then harrow, reduce to fine tilth, and roll the ground well before putting in the seed. Mr. S. Edwards Todd, in a prize essay on flax culture published six years ago, lays great stress on the matter of reducing the soil to fine tilth and rolling well, the object being to have the surface of the ground as smooth and uniform as it can be made, so that the flax may get an even start, grow more uniformly, and the surface of the ground be better to work over when the flax is pulled. Of course all stones should be removed or pressed into the earth, and lumps are to be equally avoided. Phosphates, plaster, ashes, and salt are considered the best manures. Dr. Ure recommends a mixture of 30 pounds of potash, 28 of common salt, 34 of burnt gypsum, 54 of bone dust, and 56 of magnesia, which he claims will replace the constituents of an average acre of flax. Belgian farmers use liquid night soil or other liquid manure collected from the cow-house and stables. It is fermented in cisterns and is sometimes mixed with oil cake. One trouble with stable manure is its liability to contain ungerminated seeds of weeds, which is as fatal as a weedy soil. And weeds may also be sown with flaxseed that has not been carefully selected. As a final preparation for sowing the seed it has been advocated to run over the ground with a harrow the day the seed is to be sown to destroy all the little weeds that may be just appearing, then put in the seed while the soil is fresh.

Only the best quality of seed should be used. Mr. J. R. Proctor, of Kentucky, advocates the white blossom Dutch as the best seed for American flax-growers. In all cases the heaviest, brightest, and plumpest seed should be preferred. Finer fiber is obtained from early sown flax than from later sown, and two bushels per acre is the smallest quantity that should be sown when the best results are desired. When sowing for the production of seed alone, two pecks to a bushel will suffice, this allowing the plant to branch. The larger the quantity of seed therefore, the finer the straw, and likewise the fiber. (Note the quantity of seed sown in Belgium). After sowing use the brush harrow; some growers also advocate rolling. As to time for sowing, a New York grower says:

> Sow when the soil has settled and is warmed by the influence of the sun, and weeds and grass have begun to spring up, and the leaves of trees begin to unfold.

Too early sowing may result in injury to the young plants. The weeding, when this is necessary, is performed when they are less than five inches high. Mr. Todd's practice for the removal of the coarser noxious weeds like thistles, dock, etc., is to send a man into the field shod with three or four pairs of woolen stockings, to avoid injury to the plants by treading them into the soil. This is done when the plants are about 8 inches high. When the leaves begin to fall and the stalks to assume

a yellowish tinge, it is then time to harvest, and this is practiced abroad almost universally by pulling. In this country, where so much farming is done on the high-pressure principle, the reaper is depended upon, though the results are not as satisfactory as when the more tedious foreign methods are practiced, particularly as there is loss of fiber.

Where the land has been well prepared and made smooth in the manner that has been indicated, it is possible to cut low. By this course there will be considerable fiber saved, though still a loss of several inches of the best of the stem. Recalling the many wonderful inventions in agricultural machinery in late years, a thoroughly successful machine flax puller would seem a possibility, were such an implement demanded. Such machines have already been tried in the West. It is a positive injury to the fiber to allow the seed to mature upon the plant where it is desired to produce the best results. Some assert that it will ripen equally well after harvesting, but in any event the quality of the fiber is the first consideration. Securing the seed is the next operation after the crop is harvested, called "rippling." There are machines to accomplish this, although the work can be well done in an ordinary thrashing machine by opening the "concave" so that the teeth will just come together; then, with one man to open and pass the bundles, another takes them by the butt ends and spreading them in fan shape, presents the seed end to the machine. The straw is not released, the operator withdrawing it again as soon as the seed has been torn off. With a whip the loose seed is shaken out and the flax rebundled. Some, however, perform the operation without breaking the bundles. The best method of separating the seeds is to pass the heads through plain rollers, free at one end, which avoids injury to the fiber; and there are powerful machines for this purpose to be obtained in Great Britain. Whipping out the seed against a sharp stone set up at an angle of 45 degrees is a New York method. Two or three smart blows, the bundle being held in both hands, will accomplish the result.

Now comes the important operation of retting. In this country the fiber is separated from the stalk by dew-retting almost wholly. The best results are accomplished by the foreign method of water-retting, which necessitates the building of "steep-pools" especially for the purpose. A moist meadow is the proper place for dew-retting, the fiber being spread over the ground in straight rows, at the rate of a ton to an acre. If laid about the 1st of October, and weather is good, a couple of weeks will suffice for the proper separation of the fiber and woody matter. When the retting is progressing unevenly, the rows are opened with a fork or turned with a long pole.

For water-retting the softest water gives the best results, and where access can not be had to lakes or sluggish or slow running streams, "steep pools" will have to be built.[1] A pool 30 feet long, 10 feet wide,

[1] There is always objection to retting flax in quantity, in the running streams, for sanitary reasons.

and 4 feet deep will suffice for an acre of flax. Spring water should be avoided, or if used, the pool should be filled some weeks before the flax is ready for it in order to soften the water. It should be kept free from all mineral or vegetable impurities. The sheaves are packed loosely in the pool, sloping so as to rest lightly on their butt ends, if at all, for it is considered best to keep the sheaves entirely under water without allowing them to come in contact with the bottom. Irish growers cover with long wheat straw or sods, grass-side down, the whole kept under water by means of stones or other weights. Fermentation is shown by the turbidity of the water, and by bubbles of gas, and as this goes on, more weights are required—for the flax swells and rises. If possible, the thick scum which now forms on the surface should be removed, by allowing a slight stream of water to flow over the pool. The fiber sinks when decomposition has been carried to the proper point, though this is not always a sure indication that it is just right to take out. In Holland the plan is to take a number of stalks of average fineness, which are broken in two places a few inches apart. If the woody portion or core pulls out easily, leaving the fiber intact, it is ready to come out.

When the retting has been accomplished the bundles should be taken out by hand, for the use of pitchforks may injure the fiber, and set up on end that the water may drain off gradually; twenty-four hours is a sufficient time. Then the bundles are opened and spread evenly over a newly-mown grass field to cleanse the fiber and improve its color; being turned occasionally by poles, that it may color evenly. Three or four days will suffice for the grassing, and then, if thoroughly dry, the flax is ready to lift, tie in sheaves, and be put under cover, ready for scutching.

There are many different modes of retting practiced in foreign countries, not touched upon in Part I of this report; all are interesting, but as far as the American flax-grower is concerned, enough has been stated to show him what is required to produce the best quality of fiber.

The one great drawback to successful cultivation of flax in this country is carelessness. Many a farmer feels that he can not afford to waste time over such nice manipulation and careful treatment. To all such I would say: Don't try fine flax culture for profit, for you will necessarily have to compete with foreign skill and low-priced labor, and will need all the more to make hard work of it until you have acquired experience and knowledge. But the American farmer is progressive; he has brains and ambition, and inventive genius will aid him in surmounting many difficulties if he will work intelligently and stick to it. Not one year or three, but year after year, growing each season a little flax, growing it well, and striving with the acquirement of skill and experience each year to produce the best results, and in the end he will be enabled to successfully compete with the foreigner and drive his product out of the market. But the farmer must keep both eyes open, making a study

of the crop from the time the land is plowed until the last operation has been performed. In this way, each year's experience will suggest improvements in the next year's practice, and in time a profitable flax culture will be the crowning result.

PRESENT SUGGESTIONS.

In the preceding account of how the crop should be managed I have considered the cultivation of flax for *fine* fiber only. Recalling the figures of seed production in the United States, it is shown that already a large area is annually cultivated in flax for the seed alone, the amount of fiber utilized being quite small. A certain (or uncertain) quantity is produced each year, however, of which the greater part is represented by upholsterer's tow; a small quantity goes into bagging stock, perhaps, and a less amount into twine. The remainder of that which is used goes into paper stock. In Ireland they grow for fiber, and, as a rule, throw away the seed; in America we grow for seed, and, as a rule, throw away what fiber there is. If the Irish peasant is accused of being wasteful, what can be said of the American farmer? How to utilize these vast stacks of Western flax straw and make them a source of income to the grower is a problem which the farmers themselves must work out. A great deal of the straw is so good that it ought to be much better. It is possible to grow for both seed and fiber, though the fiber will be coarse, naturally, and only fit for the lower classes of manufacture. It is practically good for nothing, as at present produced, in its tangled, short, and broken condition, unless for paper, and its demand for paper stock is not large. Will it not be for the farmer's interest, then, to adopt new methods, even when growing for seed? Will it not pay him to give a little better preparation to the seed-bed, making it smoother, so that he will be enabled to run the reaper knives as near the roots as possible, and get the full length of straw? Then let him discard the ruinous practice of tearing the straw into fragments in taking off the seed. Let him keep the straw straight, water-ret it if he will take the trouble, or carefully dew-ret it if he thinks the water-retting will not pay, and there is not the least doubt but he will make enough more out of the crop, in addition to the value of the seed, to compensate him handsomely for his trouble.

As to the matter of scutching the straw, that need not be discussed here. When the better quality of straw is produced, there will be scutch-mills if they are needed. In this connection reference should be made to the communication of Mr. Ross, on another page, whose interesting statements show that good fiber can be produced without the operation of scutching. The beautifully prepared samples of Western flax, grown for seed but kept straight, which accompanied this communication, were hackled directly from the breaker. There were also fine tow samples that are among the best that have been received by the Department.

Letters were sent by me to some half-dozen leading flax manufact-

urers, asking their opinions as to the value of the Western flax straw as at present grown, its possible value with a little better cultivation and preparation, as outlined on a preceding page, and a consideration of the flax industry in general from the agricultural stand-point. These replies bear such valuable testimony, and the opinions carry such weight, considering the high sources from which they emanate, that they are produced entire, or with the omission only of general remarks not bearing specially on the subject.

The first is from Mr. A. R. Turner, jr., president of the Flax and Hemp Spinners' and Growers' Association, and is an important document.

FLAX AND HEMP SPINNERS' AND GROWERS' ASSOCIATION.

BOSTON, MASS., *February* 4, 1890.

MY DEAR SIR: I am in receipt of your valued favor of the 21st ultimo, which has had consideration.

The culture of flax for fiber demands careful attention at the hands of the farmers, and this care has not been given while cereals have been very profitable. With the reduction of margins on cereals the growth of flax claims new attention, and it should now be of interest to farmers to give special attention to flax.

As to duties on flax, it may be well to retain them for the present to stimulate the raising of the fiber and to help the farmers in price at this time, and until they may have established a business on such a basis as to reduce the cost of production materially from the present cost to them. I am sure that if we can re-establish flax culture that with it we shall perfect new methods and cheapen the production so as to be able to compete with foreign nations. I venture to predict that the day may come when we will be exporting flax. When that time comes no duty will be needed on raw material.

The United Kingdom of Great Britain imported last year about 90,000 tons of flax and flax tow, all this being in addition to home production. The importations were as follows:

	Tons.
From Russia (about)	66,765
Germany (about)	2,101
Holland (about)	4,869
Belgium (about)	12,832
Other countries	2,591
Total	89,158

Valued at £3,066,144 sterling, this would average a ltttle less than 7½ cents per pound. This price has only general value, as the statistics do not give detail of flax and flax tow.

At present we have a home demand for good flax fiber for yarns, thread, etc., but many farmers who have shown samples have offered inferior flax, raised from poor seed, and the fiber has not been properly cleaned. While the making of threads requires a strong flax, many grades of flax not fitted for threads are suited for weaving, and it is a thoroughly practical matter to make coarse linens from ordinary grades of Western flax when sufficient protection is given the manufacturer in the producing of goods.

The manufacturers can not co-operate with the American farmers to-day as much as they desire, because the supply is insufficient, and the manufacturers, for self protection, are obliged to buy in European markets (at certain seasons of the year) in order to command the best assortment and lowest prices.

That we can grow flax is shown by the acreage of flax grown for seed.

The report of the Chicago Board of Trade is as follows:

	Acres.	Bushels.	Value.
1887	1,284,812	10,619,742	$9,679,703
1888	1,081,751	9,479,571	9,232,365
1889	1,060,285	9,816,320	10,580,855

The above covers acreage of flax raised for seed only, and the question arises can we profitably grow flax for the fiber as well as for the seed? That there has been good flax fiber raised in the United States through a long series of years, as well as good flax fiber being raised at this time, is an established fact. Many years ago, flax was raised on small farms where the fiber was prepared and spun, or spun and woven, for domestic uses. In recent years the spinning-wheel and hand-loom have given way to the power machinery in factories, and the raising of flax in small plots has been discontinued. Encouragement has not been given to the raising of flax because the supply of linens is principally imported, and we have lost our position as manufacturers in the linen trade. Cotton and woolen products have had good protection from foreign competition, but the flax and hemp productions have had less protection and have suffered in consequence. The manufacturing of twines is carried on extensively in the United States, and the manufacturing of threads has assumed fair proportions, the growth of the different branches of these industries depending largely on the amount of protection.

The importations of brown and bleached linen ducks, canvas, etc., for the year ending January 30, 1888, amounted to	$14,003,235
The importations of flax	1,802,089
Threads and twines	516,013

The references just given apply only to flax and linen goods, and do not cover hemp and jute products.

The exports from the United Kingdom of Great Britain of plain unbleached or bleached linens for the year 1888 amounted to £3,749,088, and for a period of seven years 52 per cent. of the exports of this class of linens have been sent to the United States.

The American Economist, of New York, dated January 3, 1890, refers to an article of a Washington correspondent of the New York Herald, and among the reasons he gives for the lack of success in the linen industry is the following:

"Another reason is that when, in 1861, Congress enacted tariff laws, there was no association to set forth the linen interest."

It is evident that in the past our legislators have not given the attention that should have been paid to the flax and linen industry, and, as a result, we are not in a commanding position to-day. It would seem wise that Congress should place in the hands of your Department a special appropriation for investigation, and to establish experimental stations and determine just what can be done with the tangled straw or with the straight straw of flax grown for seed, the seed being removed without tangling the straw. This appropriation should be sufficiently large for you to secure able talent, and to place experiments in the hands of men who have had a life-long experience, and who know the needs of the trade.

Some plan should be devised to save all the fiber that is now being wasted, and to me it seems a safe statement to make that it is possible to preserve all the fiber from flax even though it may be sown primarily for seed. Your experiments should also cover the raising of long and strong flax from the best seed, the aim being to produce the best possible quality of fiber. Sowing, cultivating, harvesting, retting, breaking, and scutching should all have your attention with a view to perfecting improved methods and minimum cost of the production, and when you have arrived at a practical solution of the problem you will find farmers and manufacturers ready to co-

operate with you to establish a large business in the United States, and produce our own linens, in the place of depending on foreign nations.

It is not my desire to make my letter to you cover too much the question of tariff legislation, but we must have a demand for the fiber if the raising of it in large quantities is to be a success, and the market for the fiber is dependent upon having sufficient protection against foreign competition to build up the manufacturing industry. This statement will be sufficient to show you why I have necessarily referred to the question of protection, but I have aimed to simply touch matters of fact rather than to submit an argument.

The raising of hemp is increasing in quantity, and while the greater part of the crop is still raised in Kentucky they are also cultivating hemp in other States. There is great need of a good power hemp brake to supplant the primitive hand-brake, but although three hundred patents have been issued for power-brakes in a series of years, up to the present time none have been adopted as a practical success, although several brakes are now being perfected with a fair prospect of success.

In your consideration of fibers, flax and hemp should have special consideration before the many new fibers which are constantly brought to your attention. The successful raising or manipulating of many new fibers is a matter of speculation, but with flax and hemp you have positive matter in hand, and fibers about which there is no speculation. The United States is the first nation in the world in the consumption of linens and binding twine, and this should inspire us to secure a home production for our own home market. We have favorable climate, rich and extensive lands, the need of diversified crops, and a ready market the best in the world; it remains for a proper adjustment of conditions, and special support of the Government through you, to establish enormous industries of national reputation.

If I can be of further assistance to you, I should be pleased to serve you.

Yours, very truly,

A. R. TURNER, JR.,
President.

CHARLES RICHARDS DODGE,
Special Agent, Fiber Investigations.

Another communication, with valuable suggestions on the subject, was received from Mr. John H. Ross, of Boston, whose long experience in handling flax fiber, as well as knowledge of the requirements of the industry from the manufacturer's standpoint, enables him to speak authoritatively. Mr. Ross makes statements as follows:

BOSTON, *February* 7, 1890.

DEAR SIR: I have had before me for several days your favor of the 21st ultimo, and have held my reply that it might be accompanied by the samples I send herewith, and which are necessary to illustrate the points I wish to make. I would reply to your questions as follows:

I am not aware of any use to which the Western straw in the tangled condition in which it comes from the thrasher can be put other than to use it as upholsterers' tow. I have never seen the tangled straw retted or treated in any way which fitted it for spinning purposes. I would note here, however, that I regard it as possible that a thorough process of water-retting, such as I shall refer to later, may bring the tangled straw into a condition suitable for spinning into binder twine. All the tangled straw that I have seen retted has been treated by retting on the grass, which process I do not consider suitable for getting the best results from the Western straw. All the dew-retted tangled straw I have seen has been very imperfectly retted and cleaned, and not suitable for any spinning purpose.

To obtain the best results as to quantity and quality from the Western straw, as at present sown and cultivated for the seed, I believe that the straw should be cut, or better, pulled and kept straight, and the seed removed by rippling or some similar

process which will not tangle the straw. The straw must then be steeped in water in streams, or in pits or ditches, and thoroughly water-retted, the process being carried as far as is possible without positively endangering the strength of the fiber. Then the retted straw must be thoroughly dried, and, if possible, exposed to some artificial heat immediately before being broken. In Holland the straw is dried by exposing to the heat produced by the combustion of the shives and dust from the brakes, and this drying process is attended by a boy. The dry straw should then be passed through a brake provided with several sets of fluted rollers, so that the straw, rendered brittle by the drying process, will be thoroughly broken up, and the greater part of it will fall, and that which remains on the fiber will be loose and will be easily detached by the subsequent processes of hackling, carding and spinning, thus yielding a clean yarn.

It will be noticed that this method of treatment omits the process of scutching. This is always the most expensive process in the preparation of the flax fiber, and when applied to so short and weak a fiber as is produced in the West under the present system of cultivation, it would cause a large product of scutching tow, and would raise the cost of the fiber beyond its market value.

I send, in the accompanying box, samples of the hackled line and tow produced from Western straw which has been kept straight and retted in water and passed through a brake without scutching. The samples of coarse line and tow represent a product of 50 per cent. line, and about 40 per cent. tow, and 10 per cent. waste, and are suitable for spinning into medium and coarse twine, and for the warp and weft yarns in coarse crashes, etc. The samples of the fine line and tow show what can be produced from this flax when thoroughly hackled, and from this line can be spun a 50-lea weaving yarn suitable for many of the finer and even some of the finest of the linens on which the Flax and Hemp Spinners and Growers' Association asks an additional duty that they may be made at home instead of imported from abroad. The fine tow is suited for fine weft yarns for weaving purposes.

These samples of water-retted flax were produced from flax grown near Cedar Falls, Iowa, for seed purposes, and well illustrate the possibilities of this fibre when properly handled and grown as at present without additional expense to the farmer except the keeping of the straw straight and the rippling of the seed.

It should be noted that the straw from which this fiber was produced was longer than some of the Western straw. It is, however, perfectly practicable to hackle a shorter flax than this, although the longer it is the better, both for the growth and the spinner. Of course if more and better seed was sown, and the young plants weeded and pulled a great improvement both in quality and quantity would result, but even as at present a fiber can be produced which will compare favorably with the average of the water-steeped flaxes now exported from Russia.

I would note here that I have recently received samples of flax from Wisconsin grown for the fiber from imported seed and water-retted, and this flax will compare favorably for fineness and spinning quality with the higher grades of European flax. It is suited for the finest yarns, and while there is but little demand for such fine flax in this country, it could be exported and would find a ready sale among the foreign spinners of fine weaving yarns.

This flax well illustrates the fact that with proper care and attention we can produce in our Northwestern States flax fiber fully equal to any now grown in Europe, and if our farmers are willing to give this care and attention, it is quite unnecessary for us to import any flax at all.

To produce a good dew-retted fiber from our short and weak straw we should follow the methods employed by the Russians, who obtain a good fiber with the shives loose and not sticking fast, as is the case with our dew-retted flax; this loose shive falls out in the process of manufacture, yielding a practically clean yarn. I believe, however, that the water-retting process is more worthy of attention, as it will yield a stronger and better fiber from our straw than by any other method.

There is not to-day any large outlet with us for such a fiber as can be produced from the western straw as now grown, but if adequate protection be granted to the would-be producers of woven linens, there would be at once a place for a cheap home-grown fiber for weaving yarns, and I believe even that this fiber, when produced in quantity, can be sold at a price which will admit of its exportation, and it will compete successfully abroad with the European grown fiber.

The tangled straw, if properly retted and cleaned, may be adapted for bagging, binder twine, and very coarse twines; I can not speak with any definite knowledge on this point, as I have never seen any properly-retted tangled straw, and have therefore no practical knowledge of its capabilities. It is absolutely necessary that the straw be kept straight that it may be worked for the best uses of which it is capable; a method of stripping the seed which will admit of this is absolutely essential.

Yours, truly,

(Signed) JOHN H. ROSS.

CHARLES RICHARDS DODGE,

Department of Agriculture, Washington, D. C.

From Mr. Edwin A. Hartshorn, of Schaghticoke, N. Y., than whom the American farmer has no better friend or the theory of protection in its broadest sense no better advocate, some valuable suggestions are received. As a part of the letter referred to hemp matters, only the portions relating to flax are produced here. Mr. Hartshorn says:

The Western flax straw which remains after thrashing the seed, as at present grown, is of great value if it were not literally cut into pieces about two inches long by thrashing out the seed in a wheat-thrasher. As it is now thrashed it is practically worthless for spinning purposes. If it were thrashed in a suitable thrasher, which costs no more than by the present method, the fiber would be valuable.

I send by this mail in separate inclosure a sample of flax straw from Clay County, Iowa, which is cut short by the thrasher. You will observe that a few stalks have escaped destruction. The writer picked out a few of these stalks and retted them by our patent process in three hours, and cleaned them in our hemp-brake, and produced a fair quality of spinning tow, a sample of which is also sent you in the same package. The tow is worth 5 cents a pound on the market, and will spin into a level yarn for all coarse purposes, such as binder twine, thrashers' cordage, etc.

I agree fully with the statement that if the present flax straw, grown for seed, was only properly retted by water on the ground (or by my patent serial process, without chemicals) it would enter into many coarse goods, such as crash, twines, etc. When this position has been obtained there is no question but what the fiber would be under better treatment and capable of spinning into finer goods for twines and woven fabrics. The writer has thrashed thousands of tons of flax straw by machinery without breaking a fiber in the process. An inexpensive additional appliance for the ordinary wheat-thrasher could be supplied and thrashing-machines put upon the market, adjustable so as to thrash wheat as at present, or thrash flax in the proper way. The adjustment of thrashing flax is as follows: In the place of the ordinary cylinder carrying teeth or prongs, a cylinder of equal size should be placed, with bars of iron bolted upon it lengthways about 6 inches apart; to act as beaters. These bars should be half an inch thick by three-fourths inch width. Two pairs of rollers to crush the bolls of the flax should be placed in front of the cylinder. The cylinder, with its beater-bars revolving rapidly as the flax comes from the second pair of rollers, will beat off the seed or bolls which escape the crushing process. The first pair of rollers should have a very shallow groove, which will be barely sufficient to grip the flax straw and draw it in, but not enough to prevent the crush-

ing of the bolls. The second pair of rollers should have the least possible groove, that flax will not slip between them, but at the same time they should be almost smooth.

In regard to duty on flax and hemp fiber, I would favor a specific duty, sufficient to cover the additional cost of labor under our industrial system. The manufacturers should have a specific duty sufficient to cover the duty on the so-called "raw material," and also an ad valorem duty of 50 per cent. to cover the extra cost of manufacturing in this country. As you probably know, the entire flax-spinning industry of the country has asked for an increase of duty on woven linen coarser than "sixteen hundred," which we ought to have.

Here is added testimony from another well-known spinner, of Webster, Mass.:

STEVENS LINEN WORKS,
Webster, Mass., February 6, 1890.

DEAR SIR: We have not used any flax grown in the United States since 1881, and but a little since say 1875. The most of the United States flax we have used came from Washington County, N, Y., and that vicinity, although some years ago we worked some from Ohio. If well retted and worked it is worth more than the quality that we import from Russia.

If the Western flax straw was grown a little less for seed and more for fiber, and kept straight, fairly retted, broken, and scutched, it would answer our purpose.

I can hardly tell whether the labor prices would make flax line profitable or not, but should think an article of tow might be produced at a profit, though the demand would be limited * * *

I am, yours truly,

E. P. MORTON, *Agt.*

CHARLES RICHARDS DODGE,
Special Agent, Department of Agriculture.

In connection with the question of fiber preparation, brief reference may be made to the process of Mr. S. S. Boyce, of New York City, for cleaning flax without first submitting the straw to the process of retting, thereby obtaining the fiber at once. Samples of flax so treated were shown me by Mr. Boyce in December, 1888, and a small series was subsequently sent to Paris with the fiber exhibit, though the samples were not wholly satisfactory. After a year's further experiment a number of samples from different lots of fiber produc d in quantity have been submitted which promise better results. It should be borne in mind, however, that the only practical trial of a fiber is to test it in manufacture. This I understand is being done with a quantity of the fiber produced by this process, the results of which will be awaited with interest.

In a communication from Mr. Boyce, submitting these samples, some remarks on western flax straw are made, from which brief extracts are reproduced.

For paper stock no better material than this flax straw can be desired, save that the farmer stands in his own light in not preparing his land to cut the straw close in order to give a greater length. If properly thrashed it would be doubled in value And if properly prepared (in the subsequent operations), would furnish a fiber worth $75 to $100 per ton for coarse weaving, which would take it away from the paper-maker who objects to stock costing over $50 per ton. For binder twine, bagging, salt bags, and coarse products generally, the straw as now grown for seed may be adopted and supplied with the simple modifications of (1) Cutting close to the ground. (2)

Thrashing without shortening or breaking and tangling. (3) Using imported tow-producing machinery. Of course, sowing a larger quantity of seed is recommended, and cutting or pulling and binding the straw are desirable.

Mr. H. C. Putnam, president of the Eau Claire (Wisconsin) Linen Company, in reply to a question relative to the value of the western flax straw per ton, as at present produced, makes this statement:

If a machine can dress it in the condition it comes from the thrashing machine and save, say 500 pounds of fiber from each 2,000 pounds of straw, it would be worth not less than $25 a ton net as common tow. Flax like sample (a nice product) is worth for spinning 7 and 8 cents per pound. If straw is cut and bound, kept straight, and properly retted, it is worth more per ton,—greater product and better fiber.

The following is an extract received from Mr. John Heany, of Buckley, Ill.:

In 1865 I was seventeen years of age, superintending a flax mill in St. Lawrence County, N. Y. The price of fiber was 25 cents per pound; previous year it was 30 cents per pound. I bought the mill. The tariff on foreign fibers was reduced through the influence of the spinners, and our raw material fell to 12 cents per pound. They called our fiber raw material, when the truth is it cost more to produce one pound of flax fiber than for the spinner to take our raw material and manufacture a pound of cloth. I was paying farmers $15 per acre for land on which to raise flax, and employing from twenty to thirty hands. The result was, in 1870, I had to leave my mill and come west to Illinois, where I became engaged in making tow from the flax as grown for seed by farmers on their new land. The tow was used for the manufacture of bagging to cover cotton bales. I was doing well at making tow, and thought, if they would let the tariff alone, I could make some money. But it was not to be. The tariff was taken off jute butts, and I was out again. The result was that millions of tons of flax straw were burned in the West every year, when it could just as well have been utilized for bagging. The South would not have been the losers, because they were paid cotton prices for bagging that only cost them about 5 cents per pound. I would say now that it looks as though the tariff was going to be reduced on manilla, sisal and jute, and flax and hemp. Instead of being reduced it should be increased on a par, at least, with the manufactured material, such as bags, cloth and yarn and twines. We could then have a show to produce our own fibers and on our own land, where the manufactured article is consumed.

Here is an extract from a letter received from Mr. John Hinde, of the A. H. Hart Company, of New York City:

After further considering your question, "What are your views regarding the advantage of re-establishing the flax-fiber industry among the western farmers, and what means would be most likely to aid in bringing about the cultivation of flax for fiber," we wish to add to our former communication that the samples of Michigan flax sent you were grown and worked by Messrs. J. & J. Livingston, Baden, Ontario, who have built a mill at Yale, Mich., where they will have fully 100 tons of dressed flax from last year's crop. This flax straw (800 tons) was pulled from the ground by hand, as all straw must be if used for fine spinning.

The western farmer, before going to the expense of pulling straw, must know that he will find a market, and in order to supply this, mills must be built, and, if the mills are successful, they must be controlled by thoroughly competent and experienced men. Messrs. Livingston have been successful workers of flax in Canada for over twenty-five years where they are now running twenty mills, and annually sow 5,000 acres to flax, and work as much more grown by farmers. Messrs. Livingston have demonstrated that they can grow as good flax for fiber in Michigan as can be produced in Canada, and we believe they would remove their entire plant to the

Western States if inducement sufficient to cover the expense was offered them. One mill could be moved and located at a time, and we firmly believe that within five years flax would be one of the largest and best paying crops in the Western States, as it now is in Upper Ontario.

We will be pleased to co-operate with you in all things that will promote the flax industry in this country.

Mr. E. Bosse, of Green Bay, Wis., in a recent communication to the Department, makes the following interesting statements:

The 6 acres of flax grown on my farm last year, and referred to in the Gazette of Green Bay, February 3, were sown the 1st of May, 1889, with 1½ bushels per acre of Belgian seed (which I consider the very best for this country). I pulled it by hand a little before ripe; let it dry standing on the ground for eight days; then bound it with rye straw, and sheltered. I thrashed it by hand and spread it on land already harvested, and let it ret by dews and rains; then stacked it in the barn again, but bound this time with its own straw. I scutched it by the old system (breaker and knives, still the best in use when the work is done by skilled scutchers). The soil is a black loam mixed with black sand about 10 inches deep, with red clay for subsoil. The result was as follows:

Sowed 9 bushels Belgian seed, at $1.50 per bushel	$13.50
Pulling by hand	32.59
Binding and sheltering	5.00
Thrashing by hand	20.65
Retting on the ground	19.40
Scutching	120.83
Shipping	10.00
Freight to Boston, about	30.00
	251.97

Product:

60 bushels seed, valued at $1	$60.00	
600 pounds tow, 2 cents per pound	12.00	
3,718 pounds fiber, at 11 cents per pound, as offered by manufacturers, Ross, Turner & Co., Boston	408.98	480.98
Net profit		229.01

I think we can estimate this as an average crop, with careful preparation of the ground (which I described in a preceding letter) and well conducted operations in retting and scutching.

One other system of retting is by water, or keeping the straw, after thrashed, in running or stagnant water, and let it remain until the woody part of the plant will break when folded it a little and the fiber is easily detached. This way of retting the flax is certainly the very best of all, and will, in my opinion, never be profitably replaced by scientific systems. Science may shorten the time of operation, but can not compare in good result with the silent and perfect work of nature in this proceeding. The water process is a little more expensive than the dew or grass retting, as it is called here, because it requires some previous accommodations and more labor, but, though it produces no larger weight of fiber, it is more reliable, as one can control the full progress of the operation until the proper and desirable degree of retting is attained. Besides, it gives fiber which always find a ready market and commands higher prices.

You will see by the figures relative to the six acres that I grow flax both for fiber and seed, and that the weight of fiber per acre is about 620 pounds. I could grow flax for fiber only, and so make a finer grade, according to the wants of manufacturers, but the result in product for the grower should be very near the same. What helps

considerably the present possibilities of raising flax for fiber with success in this country, in competition with the low wages paid in Europe, is that our land is cheap; that with so vast an area suitable for flax raising, our lands are new and fresh for that textile, and are capable of yielding a much larger yield than the artificially manured lands of the old continent. Also, where twenty-five or thirty years ago our good flax-retted straw in Belgium gave us 25 per cent. of fiber, it yields now from 16 to 20 per cent., with great depreciation in quality. I raised last year (and could hardly fail to raise the same) such quality of fiber as was never surpassed anywhere, and obtained from the same raw flax as that I send you to-day a yielding of 31 per cent. of fiber, for which I never heard of a precedent in the old country.

All the States and Territories north of the thirty-sixth parallel are fitted for the cultivation of flax for fiber, except those Western lands where there is lack of rain. As generally flax grows better in low lands and damp, temperate climate, I believe Michigan, Wisconsin, Illinois, and Iowa would be the States producing invariably the most and best quality of fiber.

The following extract is from a letter received from William Rutherford, of the California Cotton Mills Company, East Oakland, Cal.:

About two years ago we interested some farmers to grow trial lots of flax especially for the fiber, and to a certain extent the experiment was successful. * * * In the prosecution of this industry we received sample lots of flax from Oregon and Idaho which were good specimens of the fiber, and proved conclusively that the best quality of flax could be produced in these regions. That from Moscow, Nez Perces County, Idaho, was excellent.

It would seem from the foregoing that no further testimony is necessary to show that flax culture can be made an American industry in the near future, though the farmers and the manufacturers must work together to bring it about. As to the question of "encouragement" through legislation, I think with Mr. Turner that one form of legislation desirable would be an appropriation for purposes of experiment by the Department of Agriculture for the practical demonstration of the possibilities that have been briefly considered in the pages of this report. I will therefore leave the subject at this point for the present.

THE HEMP INDUSTRY.

Hemp culture being already an established American industry, it will not be necessary to go into the subject at great detail in the present report. Some interesting communications have been received, however, which, with some matters of general information obtained by the Department special agent, in the field, are herewith presented.

Statistics on hemp production show a steady decrease since 1860, probably due to the decline in American ship-building and to the introduction of manila fiber or "manila hemp" produced in such quantity in the Philippine Isles. The figures may possibly show a slight increase when the next census is taken, from the fact that considerable quantities of hemp are now used in the manufacture of binder twine employed in the machine-binding grain harvesters and for other purposes, from Northern grown hemp.

The only hemp which comes into direct competition with the best American hemp is the Russian. Kentucky hemp, however, possesses greater flexibility than that of the Russian and can be dressed finer, although the Russian is more equal in length, and while less flexible is preferred when the cordage is to be used for shrouds and stays in the rigging of vessels. The best hemp comes from Italy, though but little of it appears in our market. The principal uses of hemp in this country are in the manufacture of cordage, binder and other twines, and for mixing with flax in a cheap grade of carpet. Some facts in the production of hemp for binder twine will be referred to on another page, and as they relate to the cultivation of hemp in other States than Kentucky they are especially interesting. Regarding the growth of hemp in Kentucky, in former times considerable cordage was manufactured within the borders of the State, although in more recent years this industry has declined greatly, and probably most of the hemp grown in the State is manufactured in other sections, going to the New York and Boston markets chiefly.

In November, 1888, I visited the "Blue Grass region" of Kentucky, which is the center of hemp production, and through the courtesy of Mr. W. B. Hawkins not only secured interesting specimens of hemp stalks and fiber but valuable information regarding its cultivation. Mr. Hawkins is a successful hemp-grower, having raised as high as 1,648 pounds per acre. His average yield for the season of 1888 was 1,400 pounds per acre for a field of 65 acres. Hemp is grown in rotation, small grain followed by clover putting the ground in the very best condition

for the growth of the fiber. The hemp is cleaned in the field, the cumbersome slat brake which has been in use for a hundred years or more in Kentucky being still employed. The cleaning is done in the field in order that the waste portion or "shive" may be returned to the soil again. This is burned and the ashes spread over the land; as the waste in its unrotted state would be injurious to the soil. Speaking to Mr. Hawkins of the need of improved machinery for cleaning hemp, it was stated that the old method suited the colored people better, as breaking hemp in the winter was the main dependence for many of them.

The farmers of this section, as a rule, dew-ret their hemp, although it is stated that the manufacturers prefer, and the Navy regulations require, a water-retted hemp. As long as the hemp product is used chiefly for twine and cordage, the extra labor and expense necessitated by water-retting is hardly warranted. With the demand for spinning hemp, at better prices there would be a demand for water-retted fiber. I was shown in Frankfort, at the Kentucky River Mills, crash toweling from hemp that had been in use for many years, and to all appearances it was as good as the same grade of fabric from flax. It is said that Henry Clay introduced into Kentucky the practice of retting by water, but few farmers of the present day are willing to take the trouble to follow it, notwithstanding the better results that the practice would give. The hemp stalks are usually spread upon the same ground where grown, and when sufficiently retted, as is determined by breaking out a little, it is again put into shocks. Hemp retted in winter is of a brighter color than that spread in October. The crop requires a rich loamy soil.

In a recent communication Mr. Hawkins details the general practice of Kentucky growers at the present time, as follows:

The usual procedure in the cultivation and handling of hemp is about this: Our best land produces the best hemp. Virgin soil sown to hemp can be followed by hemp for fifteen to twenty years successively; sown then to small grain and clover; can be sown to hemp every third year (no fertilizer required) almost indefinitely. Given blue-grass sod: Plow not over 4 inches deep in the fall or early spring; sow about the time to plant corn; sow broadcast 33 pounds of seed per acre, having first prepared the seed-bed thoroughly, and cover by dragging with the harrow as for any of the small grains, wheat, oats, etc. No cultivation can be done, of course, as it is broadcast.

About one hundred days are required for the crop to mature ready for the knife, or when the first ripe seed can be found in the heads. The hemp is then cut and spread thinly, covering the ground it grows upon; it must be kept from tangling. Let it lie for one or two weeks to cure; rain will not injure it in this time. Now rake into bundles and tie (be careful to keep straight), about 10 inches in diameter, and stack dry, about two acres in the stack. About December 1 we spread on the ground, as before, and when retted sufficiently set upon end in shocks about the ordinary size of corn shocks, and the hands can carry their brakes from one shock to another in the field to brake it out. Much depends upon the retting, and must be determined by

testing when it is ready to take up. The approximate cost of an acre of hemp in Kentucky, counting man and team worth $3.50 per day, is as follows:

Plowing	$2.00
Harrowing	1.00
Seed, at $3	2.50
Cutting	3.00
Taking up and shaking	3.00
Spreading	2.00
When retted, shocking	1.00
Breaking, $1 per 100 (the usual crop being 1,000 pounds)	10.00
	24.00

There is no reason why hemp culture should not be extended over a dozen States and the product used in manufactures which now employ thousands of tons of imported fibers. In the manufacture of binder twine alone there is an outlet for upwards of 50,000 tons of hemp annually. The twine is now made from manila and sisal chiefly, the first being no better than hemp and the last-named quite inferior. American hemp twine is said to run 100 feet more to the pound than sisal, 5 pounds of American hemp twine, at the same price per pound as sisal, going as far as 6 of sisal, an advantage of about 17 per cent. in favor of American hemp. See also letter on page 67.

When the market for binder-twine was first created, American hemp filled the demand, the more carefully prepared article, straight or dressed hemp, being employed. About ten years ago the demand increased to a point beyond the supply of native hemp, and to meet the exigency of the case other fibers were employed: Manila and sisal came into use, and as the consumption of binder-twine grew to its present enormous proportions, these fibers held their position, and hemp was relegated to the background. The recent enormously high price of sisal and manila twine has again called attention to hemp. By lessening the cost of production by the use of labor-saving machinery in all operations of production, it has been possible to cheapen hemp, and with a little present protection the foreign fibers can be driven out of the market and the farmer receive a two fold benefit from the change.

The grain growers will be the hemp producers, and in point of fact will only take from their own pockets in buying twine what they get for their raw hemp, with the simple cost of manufacture and dealers' profits added. It is proposed as a relief for the American farmers from the unwarranted high prices of binder-twine last season to remove the duty on certain imported fibers.[1]

[1] It is claimed that if manila, sisal, sunn, New Zealand, and other hemp substitutes are placed upon the list of free raw materials it will be because some of the farmers in the West have demanded it, in view of the present agricultural depression, to cheapen the present cost of binder-twine. No doubt should this occur the few manufacturing firms in the United States who produce binder-twine from foreign fibers will thank these farmers who have actually aided them in the accomplishment of a much desired object that they have been unable to bring about through their own efforts. There are many Western farmers, however, who look at this matter in its true

A surer relief for the farmers would be the distributing among them of the $4,000,000 or $5,000,000, which the production of this fiber would mean, with a possible saving of two or three millions more in the difference between the price for which a good hemp twine could be sold and the prices paid last year for a twine of foreign fiber.

I am informed, upon reliable authority, that the proportion of hemp twine to twine of manila, sisal, etc., that will enter into the present year's supply will not be over 10 per cent., or about 5,000 tons. This twine, in car-load lots, can be sold at 12½ cents per pound against 16 cents for manila. If only one-half of the binder-twine out-put were made of hemp, at these prices there would be a clear saving of $1,750,000 to the consumers in a single year from difference in prices alone. And I am informed upon equally reliable authority that the machine binders work with hemp twine quite as readily as with the stiffer twines from sisal and manila when a well-made hemp twine is used.

A great deal has been said on this subject, the principal objections coming from those who are especially interested in manila and sisal, but the fact is, and it can be proved by abundant evidence, that the "prejudice" against hemp twine has no substantial foundation. In this connection I can but present a letter on the subject, received while this report is in press, which explains itself.

[D. M. Osborne & Co., Manufacturers of Harvesting Machinery.]

AUBURN, N. Y., *March* 29, 1890.

DEAR SIR: We have your esteemed favor of the 26th instant, making inquiry as to our judgment of the value of American hemp twine, commonly known and called as "Kentucky hemp binding twine" for harvesting machinery.

We have sold several thousand tons of this twine, and without exception it has given the best of satisfaction to the farmers using it on their self-binding harvesters. The standards for binding twine are, pure sisal, 500 feet long; half manila and half sisal, 550 feet long, and pure manila 600 feet. American hemp when spun 525 feet

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light, as is shown by the large correspondence of the Department relating to fiber matters, received since the fiber investigation began. These farmers see what is the fact, that every pound of binder-twine used can be made of native grown fibers, that the twine will be as good as the best manila, run as many feet to the pound, and can be produced at a saving of at least 4 cents a pound from the present prices. With free foreign fibers the saving to the farmers by the removal of the duty will not be over a cent a pound, and it remains to be seen whether the farmer will get *any* advantage, as the production is now limited to a few manufacturers, who, it is claimed, even control the supply of raw material, thus shutting off all competition. At lowest estimates we are now importing raw fibers and fiber manufactures to the extent of $26,000,000 (out of some $44,000,000, total imports), that could be saved to the country. The Department of Agriculture has just initiated an effort to re-establish the fiber industry in the United States, that the farmers of the country may gradually secure to themselves this $26,000,000 through the cultivation of two easily grown crops. It is needless to say that if these foreign hemp substitutes, and jute especially, are placed upon the free list, these efforts in a measure will be hampered and the farmers themselves will be the losers. Both binder-twine and cotton bagging should be made from flax and hemp grown on American farms.

long is the equal of sisal, half each sisal and manila or pure manila, of the lengths given above.

There is no fiber in the world better suited to this use than American hemp. It is our judgment, based upon nearly ten years' experience with large quantities of binder twine each year, that the entire supply of this twine should be made from American hemp. It has been demonstrated that this hemp can be grown in the States of Kentucky, Missouri, Kansas, Southern Iowa, Southern Illinois, Indiana, Ohio, and New York, and probably several other States that are adapted to raising winter wheat. There are 50,000 tons of this binding twine used annually, every pound of which could and should be made from this home product.

Your department can do no greater service to the farming community than by widely disseminating the information as to the extent of the use of this twine for binding purposes, and the fact that American hemp is not a difficult crop to raise, and that the usual average yield upon good soil is from 1,000 to 1,500 pounds of hemp per acre.

Very truly yours,

D. M. Osborne & Co.
By G. W. Allen, *Treasurer.*

Chas. Richards Dodge, esq.,
Special Agent Fiber Investigations,

If further evidence were desirable, the testimony of farmers themselves, who use and prefer hemp twine, could be given from the large correspondence of the Department, but it is not necessary. One of the strongest of these is signed by the president of an Alliance organization in Minnesota.

HEMP CULTURE IN NEW YORK.

It may not be widely known that quite an area was cultivated in hemp last season in this State. The industry is carried on in the neighborhood of Troy and Schaghticoke where sixty years ago a considerable amount of fine hemp fiber was annually produced. I visited this section in January of the present year and obtained from Mr. E. A. Hartshorn many interesting facts in regard to North River hemp culture, which show the value of the industry to the State, an industry which will be extended, as there is a good demand for the product.

A large portion of the hemp grown in this section last season was used by the Cable Flax Mills at Schaghticoke, some twenty farmers having been interested in its production, growing it under specific conditions, in a contract with the manufacturers, who agreed to furnish the seed and pay $12 per ton of 2,000 pounds for the stalks delivered. On the other hand the farmers agreed to sow the seed on good ground, at the rate of about 1 bushel per acre, to cut the hemp at maturity, and when properly cured or dried, to deliver the same, in bundles about 10 inches in diameter, "dry and free from tree or bush hemp, weeds, thistles, grass or other objectionable matter."

They also agreed to a reduction of $3 per bushel for the seed when the yield of stalks was more than 4,000 pounds per bushel, no charge for seed being made when a less quantity was produced.

The record of the twenty crops produced under this contract is given as follows:[1]

Name of farmer.	Bushels sown.	Yield of cured stalks.	Value at $12 per ton, less cost of seed.	Net proceeds per acre (seed deducted).	Rank in production.
James Thompson	¼	3,312	$19.12	$76.48	1
Jerome Wright	1	5,630	30.78	30.78	6
Job Thomas	1	3,340	20.04	20.04	10
Nathan Craver	1	10,230	58.38	58.38	2
L. D. Ham	1	2,380	14.28	14.28	14
J. W. Fort	1¼	5,840	31.29	25.03	8
James Rogers	2	4,080	24.48	12.24	15
John Guare	2	14,000	78.00	39.00	4
Charles Herrick	2	7,620	45.92	22.96	9
Martin Hogan	2	Drowned out.			20
Albert Gifford	2	10,930	59.58	29.79	7
George Dunham	2	5,290	31.74	15.87	13
J. McGowan	2	3,540	19.85	9.92	16
E. S. Baucus	2¼	13,340	73.23	32.54	5
G. W. Brewster	3	22,590	126.54	42.18	3
J. Irving Baucus	3	670	4.02	1.34	19
George Gifford	4	5,070	30.42	7.60	17
James Rabbitt	4	11,825	70.95	17.74	11
E. J. Skiff	4½	12,333	73.98	16.44	12
John B. Wright	4½	2,940	17.64	3.92	18
Total	44½				
Average				$18.22	

The crop of Mr. Baucus, which stood nineteenth, the smallest recorded, was drowned out and not replanted. It was explained that this phase of the business the farmers did not understand, and several crops which were comparatively light might undoubtedly have been vastly improved at a small outlay for additional labor and seed. Several crops were also cut too soon, and considerable sacrifice made, both in the quantity and quality of the product.

Referring to the figures of production, the best record of income from sale of a crop, net proceeds per acre, cost of seed deducted, was $76.48. The second best was $58.38, and the best five crops averaged $49.71 per acre, exclusive of the cost of seed. The total average of twenty crops—that is, the crops on twenty farms—including the complete failure referred to, and another crop which was almost a total failure from the drowning out of the plants when they were 18 inches high, was $18.22 per acre. Sandy or loamy soils are considered most favorable, the hemp succeeding both on the "uplands" and in the "bottoms." The soil is plowed very deeply and made very mellow by the use of the harrow. Barn-yard manures or standard fertilizers are used, as the soil must be put in good fertility to produce a successful crop. The seed is sown from April 20 to May 10, and the crop is usually harvested between the 1st and 21st of September. When the stalks do not exceed eight feet in height the cutting is done with an ordinary sweep-rake harvesting machine by cutting two-thirds the ordinary width

[1] This table is taken from an interesting little pamphlet on "American Hemp Culture," relating to the recent efforts to rëestablish hemp culture in New York State, by Edwin A. Hartshorn.

of the swath, while a larger growth must be cut with a sickle, corn hook, or short scythe. It is claimed that a light frost will not injure the crop and that there need be no haste in cutting it, the plant continuing to grow until the stalks have turned a pale yellow. However this may be the opinion in New York State, where the fiber is employed in the coarser manufactures, a different idea prevails abroad; that after the proper time for cutting has arrived the fiber deteriorates, and for fine manufactures there would be considerable loss in value.

The question of rotation is little regarded, as the production of hemp is not considered exhaustive to the soil. As Mr. Hartshorn suggests, however, it can hardly be claimed that the production of an annual plant growing from 6 to 14 feet high does not exhaust the soil, though it is certain that hemp contributes more than any other crop towards repairing the damage done by its own growth through the return of the leaves to the soil, besides other matters while it is undergoing the process of retting. Hemp is an admirable weed-killer, and in flax countries is sometimes employed as a crop in rotation, to precede flax, because it puts the soil in so good condition. As a proof of its weed-killing powers a North River farmer makes the statement that thistles heretofore had mastered him completely in a certain field, but after sowing it with hemp not a thistle could be found, and while performing this excellent service the hemp yielded him nearly $60 per acre, where previously nothing valuable could be produced.

Regarding soil exhaustion by this crop, Henry Clay was of the opinion that it exhausted the soil slowly, if at all, thirteen or fourteen successive crops sometimes having been taken from the same land. It is interesting in this connection to note that in France, where a fine quality of hemp is produced, the plant is often grown on the same land without rotation, although the soil is kept up to a high state of fertility. The retting is done on grass or stubble where grown. It requires from four to six weeks, according to weather and size of the stalks. Grass land, however, is not thought favorable for the process in New York, as the hemp, when imbedded in the grass, keeps wet on the under side, and if not frequently turned over is liable to mold and the fiber to become discolored and weakened. When water-retted, from eight to eighteen days are required according to the temperature of the water.

The reader is referred to the chapter on hemp culture in France in the first part of this report, where it will be seen that water retting in Brittany requires less than half so long a time. On this point the growers will be led by experience, and it would be well to begin at once the water-retting on a small scale, for the sake of the experience and the knowledge that will be derived from the practice. The French hemp farmers from time to time break a few stalks, taken from the water for the purpose, to ascertain the condition of the fiber, so that it may not become injured from over-retting.

It should be stated that most of the crop of North River hemp grown last year was retted by the Cable Flax mills on grass ground. A por

tion was retted on the stubble ground which produced the hemp. A smaller portion was retted in stagnant water and some in running water. Experiments were also made at the Cable Flax mills in hot-water retting and likewise by a patented serial retting process consisting of: (1) Hot-water pressure; (2) A cold-air blast; (3) Steam pressure; (4) A cold water bath, all done in a revolving iron tank or boiler in about three hours. The treatment required no chemicals. As the drying is done under cover the process can be carried on with absolute safety to the fiber at all seasons of the year.

Mr. Hartshorn says:

The shives or hurds from the hemp when broken out (which is the next process of the industry), furnishes an excellent fuel, quite sufficient to make steam for retting, drying, and breaking the hemp; hence this process can not be very expensive, while the fiber produced is lighter in color and more valuable than by the old out-door process. Aside from the cost of building and maintaining a plant for this process, and the hauling of the straw instead of the cleaned fiber to market, (as when retted and broken by hand in the field), there can be but little difference in the cost of the two processes, while the additional value of the fiber and the very present risk of spoiling entire crops by over-retting out doors, the new process will speedily supersede the old.

The Flax and Hemp Spinners and Growers' Association of America, to stimulate to greater interest in the cultivation of hemp, have offered a reward for the present year to the farmers of Rensselaer and Washington Counties, as follows:

Fifty dollars to the farmer who produces the greatest number of acres, and $25 for the second largest.

Also, $50 for the largest production per acre, and $25 for the second largest.

HEMP CULTURE IN ILLINOIS.

Since 1860, or even earlier, this State has produced small quantities of hemp; the census of 1880 showing, however, but 61 tons of fiber, a great falling off from the production of previous years when there was a demand for both flax and hemp in bagging manufacture. The industry has had a considerable stimulus recently in several of the eastern counties, including Champaign, Cole, Iroquois, and Will, through the efforts of manufacturers and others in this section. The Department has had considerable correspondence on the subject from Iroquois County (though the locality has not yet been visited by the special agent), and some valuable facts have been brought out.

Mr. John Heany states that the hemp is grown extensively for fiber to be used in the manufacture of binder-twine. The crop now being manufactured is the seventh successive crop on the same land, and is said to be far ahead of any previous crop in quantity of fiber produced to the acre. Mr. Heany believes the method of cultivation and preparation in vogue is not in any way exhaustive to the soil, though the refuse should be returned to the soil if possible. In hemp culture in this section nearly everything is done by machinery, which reduces the cost of production to a very low figure. The seed is sown as early as

possible—as soon as the ground is in condition—even as early as March 25, the date of sowing last year. The land is plowed in the fall if possible, and in spring the large disk-harrow is used, followed by the smoothing-harrow. The seed is put in with a broadcast seeder and afterwards carefully harrowed. When the crop is ready to harvest it is cut with mowers, and spread evenly that the retting may be accomplished without the labor of turning over. If rainy, however, the Bullard hay-tedder is used to change the position of the straw or stalks, and to expose to the air the inside of any bunches that might be left to the action of the rains.

When retted, the stalks are raked up with the horse-rake and loaded upon wagons to transport to the breaker. Mr. H. says that 8 to 10 tons of straw per day are taken care of. The fiber is not kept in a straight form, as the twine-makers break it up on the cards, and this form of fiber suits better. The machinery used by Mr. Heany is a device of his own and not patented. As to facts he says:

I can furnish the clean fiber at 4 cents per pound at a profit. I am no theorist; I have 800 acres of hemp this year betwixt this place and Peotone, Ill. I have shipped already 60 tons of fiber to the spinning mill this fall and winter, from Buckley. I have one field of 140 acres from which I am expecting to get 1,500 pounds of fiber to the acre. It usually costs $15 per acre for rent and labor—on the product of an acre delivered on board cars. If the people would but take 3,000,000 acres of land out of the corn and oats and wheat culture, and grow hemp, we could then consume all our grain at home and save the millions we annually pay out for fibers. It would relieve the present agricultural depression wonderfully. All this fine country can raise good hemp wherever it can raise a good crop of anything else.

Notwithstanding that the aim is to produce a cheap fiber it must be admitted that this is a careless kind of cultivation which may not always give satisfactory results. In a recent communication, from another source, the danger of over-retting is referred to, and the statement made, that in practice a difference of 50 per cent. is found to exist between well saved and badly saved hemp on the same ground. It will certainly pay, even with the use of machinery, to give greater care to the matter of harvesting and retting. Our New York friends have demonstrated that it is possible to produce good fiber at a low cost, and the general effort in the North River region is toward improvement in all operations that will secure a thoroughly good quality of fiber. The best yield of hemp recorded last season in Illinois was one ton of tow per acre. Any corn land will grow hemp to perfection.

The success with hemp culture in this section has induced others to embark in the industry, and during the coming year it will be extended, not only in the State of Illinois but in others which hitherto have not been enumerated in the list of hemp-growing States. With the further extension of this industry it is claimed that it will soon be possible to produce all the fiber needed for binder-twine, and similar uses, that may be required by the country, though it is urged by those interested that adequate protection should be assured against the cheap labor of India and other foreign countries.

It is said that nearly three hundred patents have been issued in the United States for machines for breaking hemp, most of them having proved absolute failures from one cause or another, and the fact remains that the cumbersome hemp-brake, an affair of the rudest description, has held its own in Kentucky in spite of all efforts to supersede it. It is proposed therefore to notice here some recent inventions in this direction which have given promise of success.

In January I personally inspected at Schaghticoke, N. Y., a power-brake, the invention of Mr. E. A. Hartshorn, which is described as follows:

The machine consists of several pairs of fluted rollers, interspersed at intervals with peculiarly-constructed scutchers, or cleaning rollers, which pierce the hemp with steel pins, and also beat, shake, and scrape it vigorously, while it is held on either side by the breaking-rollers. By reason of a more rapid motion given to the scutching than to the breaking rollers, the breaking, piercing, beating, shaking, and scraping are all accomplished while the hemp is passing rapidly through the machine. The flutes are graduated from very coarse to fine, and the rollers are driven in such a a manner that the stalks are not crushed, but broken by the most favorable leverage.

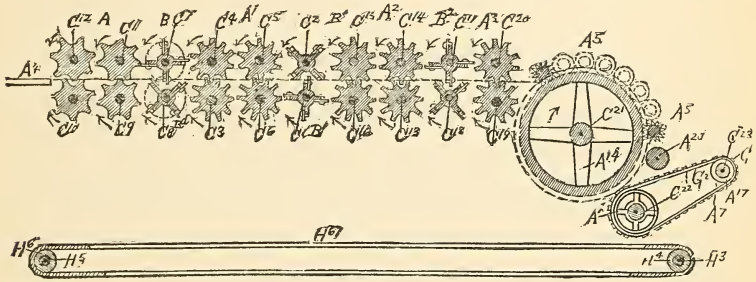

FIG. 7.—Arrangement of breaking rollers in the Hartshorn machine.

The machine, operated by three men, I was told, has already demonstrated a capacity of 10,000 pounds of stalks, or 30 cwt. of cleaned fiber in ten hours. It weighs, as at present constructed, about 4 tons, though the inventor claims that it can be materially lightened in many of its parts without the sacrifice of necessary strength. One man feeds the hemp stalks, while a second man, or boy, receives the fiber, which is given out in a continuous stream at the other end. The fiber is delivered in its full length.

In the Cable-Mills it is run in connection with the shell-card and hackling machine, which takes the cleaned fiber at once and prepares it for the next process of manufacture. In the present trial the machine was not timed.

In a former test, before witnesses, two men cleaned 100 pounds of retted hemp stalks, yielding 33½ pounds of well-cleaned fiber, in five and three-quarters minutes. From the practical working of the machine during the past fall it is claimed that it will reduce the cost of hemp-breaking from $1.25 to 25 cents per hundred weight. The "shive" or

"hurds" are used for fuel in place of the best quality of bituminous coal, and the fact was demonstrated that when used under one boiler of the series, less coal was consumed under the other boilers using coal as fuel than when coal was employed for all.

The machine alluded to by Mr. Heany, of Buckly, Ill., his own invention, and unpatented, he describes as follows:

It consists of a very large brake with fluted rollers—flutes from 1½ to 2 inches deep. The cleaning cylinders are 5 feet in diameter of any desired width, with cross-bars alternating with loose wings. In the cross-bars are pins, which are used as combs, about three-quarters inch long, slightly bent back. Under the cylinders are slats 2 inches apart to let shives through. I use one cylinder close behind the brakes. The other two cylinders have each one pair of rollers in front to hold fiber while shives are being cleaned out. The fiber is not left straight. It is claimed that twine manufacturers prefer this product to straight Kentucky hemp fiber on account of its superior strength.

The capacity of the machine is not stated, nor has it been examined by the Department of Agriculture. A hemp-grower in the vicinity writes the Department as follows:

New machinery will be tried the present season in this section; the brake in present use is not heavy enough, strong, heavy machinery being demanded. In fact, the demand is for a machine that will produce a good quality of fiber in large quantities at a small profit.

A Kentucky machine for cleaning hemp, recently tested in Lexington, is reported upon by M. A. Scovill, director of the Kentucky Agricultural Experiment Station. It is the invention of Mr. J. D. Shely, of Lexington. A description of its mechanism was not given. Mr. Scovill states that the machine is only a model, and has not yet been worked upon a scale large enough to prove beyond doubt that it will be a success.[1] It is portable, and will occupy in hemp handling about the position occupied by the thrasher in wheat raising. In the trial referred to, which was witnessed by numbers of hemp growers and manufacturers, between 50 and 100 pounds of fiber was made, the estimate for a day's work, with a force of 10 men, being 8,000 pounds of hemp, at an expense of $20. The machine is not yet patented, though protected by caveats, as it is desired to further perfect it in certain directions. Mr. Scovill also states that a number of hemp manufacturers, whose opinions were solicited by him, spoke well of its operations at the trials attended by them.

[1] Since the above was written another trial of the machine has taken place. From Mr. Scovell's letter regarding it, the following extract is taken:

"It is the first machine Mr. Shely has made of this pattern on a large working scale. There was only about one hundred pounds of hemp at the machine and this was run through in a very few moments. The power used was an eight-horse power threshing-machine engine, with 80 pounds pressure. While the machine was running everything went off smoothly, and it certainly did its work well. If it can be made to run so continuously I can see no reason why it should not be a success, but I would express no opinion, and will not, until the machine goes into the field and makes a day's run. I send you samples of the hurds and fiber by this mail, as they came from the machine last Friday. I selected the samples myself, and they are what I consider a fair sample of what the machine did."

THE RAMIE QUESTION.

What is Ramie? For the benefit of the many who may have only an imperfect knowledge of the textile, a brief description of the plant and its uses is herewith presented.

Ramie is a plant belonging to the nettle family (*Urticaceæ*), which from time immemorial has been cultivated in China, and known to botanists by the name *Bœhmeria nivea*,[1] frequently called the stingless nettle. It is also known as "China-grass," and "Rhea." It has long been cultivated, also, in Japan, in Java, Bornea, Sumatra, and in the East Indies, and during the present century has been introduced into other countries. Its introduction into the United States dates back to the year 1855.[2]

When fully grown the plant attains a height of 4 to 8 feet, clothed with large ovate-acuminate leaves that are green above and whitish or silvery beneath, the fiber being formed in the bark which surrounds the stalk, this having a pithy center. It is of rapid growth and produces from two to four, or even five, crops a year without replanting, dependant upon the climate where cultivated. In China and Japan, where the fiber is extracted by hand labor, it is manufactured not only into cordage, fish-lines, nets, and similar coarse manufactures, but woven into the finest and most beautiful of fabrics. In England, France, and Germany the fiber has also been woven into a great variety of fabrics, covering the widest range of uses, such as lace, lace curtains, handkerchiefs, cloth, or white goods resembling fine linen, dress goods, napkins, table damask, table-covers, bed-spreads, drapery for curtains or lambrequins, plush, and even carpets and fabrics suitable for clothing. The fiber can be dyed in all desirable shades or colors, some examples having the luster

[1] For present purposes it is assumed that but a single species of ramie is being cultivated in the United States. The writer is fully aware, however, that two or more recognized species of this plant have been under experimental cultivation in countries that are seeking to introduce the ramie industry, besides a dozen others, producing "rhea-like fibers," in eastern countries. The subject of the scientific nomenclature of ramie has been an interesting one to botanists, in the countries where the plant has been introduced, and the Department of Agriculture will institute a special investigation into the subject as it relates to our own country in the near future. The reader is referred to Appendix A, at the close of this report, for interesting statements in this connection, relating to culture in France.

[2] See report of the Commissioner of Patents, Agriculture, for 1855, p. 244.

and brilliancy of silk. It is one of the strongest and most durable of fibers, is least affected by moisture of all fibers, and from these characteristics must take first rank in value as a textile substance. It has three times the strength of Russian hemp, while its filaments can be separated almost to the fineness of silk. In manufacture it has been spun on various forms of textile machinery, and also used in connection with cotton, wool, and silk, and it can be employed as a substitute in certain forms of manufacture, where elasticity is not essential, for all of these textiles, and for flax also. It likewise produces superior paper, and can be utilized in the manufacture of celluloid. In short, the uses to which it may be put are almost endless, and when the economical extraction of the fiber by machinery is successfully accomplished, it will become one of the most valuable commercial products of the vegetable kingdom.

Ramie is a plant of easy cultivation. It has been grown as far north as Pennsylvania and New Jersey, though for the production of fiber its culture succeeds best in the Southern States, and particularly those bordering the Gulf of Mexico. It also thrives well on the Pacific coast, having been grown with success experimentally in California for several years.

The plant is propagated by seeds, by cuttings or by layers, and by division of the roots. When produced from seed the greatest care is taken with the planting, as the seed is very small. For this reason open-air planting can hardly be relied upon, plants started in the hotbed giving the best results. After planting, the seeds are covered thinly with sifted earth and kept shaded from the sun until the young plants are 2 or 3 inches high, when sunlight is gradually admitted to them. In five or six weeks they will be strong enough to transplant to the field.

In the East Indian method of propagating by cuttings of the stems, the spring-grown stems are used, and when fully ripe. Only the well-ripened portion, where the epidermis has turned brown, is employed, the stem being divided into lengths that will include three buds, care being taken to cut a quarter of an inch above and the same distance below the top and bottom buds. These are planted with the central bud on a level with the soil. The cuttings are shaded for ten days or more unless the weather be cloudy or rainy. In India the cuttings are planted a foot a part, although given more room as the plants mature.

By far the most practical method and the one which will give the best results in this country, is the propagation by a division of the roots of old or fully matured plants. The old plants are better than young ones for the purpose as the root-mass is larger, the tuberous portions showing a greater number of eyes and therefore giving stronger plants after division. The practice varies as to distance apart that these are planted. In India 4 feet apart each way is considered the proper distance, though in France some favor 2 feet apart each way as giving

better results.[1] In a conversation with M. Favier upon this subject it was suggested by this gentleman that when it was desired to dry the cut stalks upon the ground where grown, a system of planting upon ridges should be followed which would enable the planter to lay the cut stalks from ridge to ridge in such manner that the air could circulate freely under them in the furrows, and prevent injury from dampness.

In a former report on the culture of ramie issued by the Department of Agriculture these directions are given.

> Furrows five or six inches deep, and five feet apart are opened with the plow. The roots are laid lengthwise in the middle, close in succession if a thick standing crop is desired, but placed at intervals if nursery propagation is the object in view. The first mode will absorb 3,000 roots per acre, but will save the labor of often filling the stand by propagation.

The plants are given cultivation at first, being hilled like corn or potatoes, all weeds being kept down, though after getting a good start, from the rankness of their growth and the density of the foliage, weeds will have little chance to grow. These brief directions are sufficient to enable any one to make a beginning; experience and a familiarity with the plant and its manner of growth will suggest subsequent treatment and assist the farmer in establishing the particular practice that it will be best for him to follow. Southern cultivators choose a deep, rich, light, and moist soil. Mr. Montgomery, writing on the culture of the plant in the Kangra district of India, says:

> A rich loam suits the plants best, but they will grow in any kind of soil, provided a full supply of moisture be available, combined with thorough drainage.

If sufficient moisture cannot be assured it should be supplied by irrigation, a positive essential in many localities where ramie is grown. It must be remembered, however, that ramie will not thrive in a "wet" soil. The ground must be well prepared by plowing to the depth of ten inches, and well pulverized, and if the land is poor fertilizers must be applied to bring it up to a good state of fertility. All weeds must

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[1] M. Favier writes thus: "The close system of planting, which we recommend, requires for planting 1 hectare the first time about 35,000 to 40,000 plants. If obliged to purchase these even at 30 francs per thousand, many proprietors would seriously consider the question before incurring such an expense, and we advise those who wish to plant ramie to first purchase a few thousand of plants for each hectare which they may wish to devote to this purpose. By planting in the month of March one can produce by the month of October in the following year, that is, within eighteen months, or two years if the roots are left until the following March, from each stalk twenty new stems, or, we will say, an average of fourteen or fifteen, so that from 3,000 original roots planted one will have on hand, and without expense, the plants necessary for an entire hectare. Mr. Beau, a physician at Suméne (Gard), who has cultivated ramie with great success and who wrote us an interesting letter in 1880, was able to detach eighty new plants from a single original root.

"Some years ago plants sold for 150 francs per thousand; to-day they are not valued at more than 20 to 30 francs, and in a year from now the price will certainly fall from 10 francs to 15 francs, while within two or three years proprietors will supply themselves, or they will courteously exchange the plants among themselves, as has become the custom to do with the native grape vines."

be removed from the soil or they will sorely plague the cultivator in the first year or so until the plants have grown large. When the climate will admit of producing three crops a year, the cuttings are made at intervals of about ten or twelve weeks, the first cuttings to be made about the middle of May, dependent on the season.

STATUS OF THE RAMIE INDUSTRY.

In treating this subject as it relates to America, bearing in mind how much has been written, how much has been claimed, and how large a number of people are interested in it for one reason or another, I shall endeavor to confine myself to the simple statement of such recent valuable facts illustrating progress as the Department has been able to obtain. Nor will it be necessary to consider in detail the adaptability of the plant for cultivation in the United States, as the fact of its successful introduction has been fully established and the records of past experience placed before the world. It has also been demonstrated in Europe and to a partial extent in the United States that the fiber can be manufactured into a great variety of beautiful and useful fabrics for a wide range of employment in the textile economy. Between these two positions, however, forming either end of the industrial chain in the utilization of this plant as a textile product, there is an intermediate position in which ramie experts agree something has yet to be accomplished before unqualified success in the establishment of the industry can be positively assured. I refer to that stage in the "handling" of ramie between the harvesting of the stalks and the first manipulation of the "cleaned" fiber in manufacture. To those who know nothing of the story it may be briefly stated that the invention of machinery and processes for the extraction and cleaning (degumming) of ramie fiber in the last thirty years in the various countries where experiments are going on, might foot up a hundred or more, could the entire catalogue be enumerated.

In spite of this vast inventive effort, ramie, up to the present time, has not been grown in any country (excepting China and Japan) save in a limited way, because no machine or process for decortication thus far has been presented that has filled all the requirements demanded of a thoroughly practical decorticator. To inventors in our own country who have been working so indefatigably for the solution of this problem, some of whom may not fully coincide with this statement, the suggestion may be made that the Department of Agriculture can only recognize such facts as have been established by actual tests, and that mere claims, though honestly made, can not be conscientiously recognized. It is to be hoped in this connection that the Department may be able at some future time, not too remote, to obtain a knowledge of the value of every American invention for the decortication of ramie, by carefully conducted competitive official trials, and we hope that

when the plant is finally produced commercially in the South it will be cleaned by an American machine.

The fact that ramie is grown in no country commercially on an extensive scale, notwithstanding the large rewards that in past time have been offered for successful machinery, demonstrates how difficult of solution is the problem. The present status of the ramie question may be stated in epitome somewhat as follows:

It is not cultivated as an industry because the growers have no adequate economical means of preparing the fiber for market. It is grown industrially in China, Japan, and to a slight extent in a few other Eastern countries. It is grown to an exceedingly limited extent also in portions of Europe and the French colonies in Africa, in some of the South American republics, and in the British colonies. The commercial demand for the fiber is exceedingly limited, because, first, it has not been spun as economically as is desirable to make the industry profitable; and secondly, the real reason, because the supply of the raw material is so fluctuating and uncertain there has been no inducement for manufacturers to put large capital into factories and machinery.[1]

As there is no present large demand for fiber from the manufacturers, those who may have produced it in a limited way have found no market for their product. With a perfected and satisfactory decorticator the principal obstacle to success with the industry will disappear, manufacture will be encouraged, and, from present indications, nearly every country in the great family of nations where ramie will grow will then be producing fiber for the world's market.

It is said that the first attempt to decorticate ramie by machinery was made in India in 1816, a flax and hemp machine having been sent out for the purpose from England. Little was accomplished during the next fifty years, when the attention of inventors was called to the importance of producing a mechanical decorticator through renewed experiments with culture and the further introduction of the plant into several countries. The date of the revival of these efforts M. Favier fixes at about 1870. In America these efforts began at a much earlier period, for the machine of Dr. Benito Roezl was patented September 17, 1867, and it is said that hundreds of them were made at a foundry in New Orleans and offered for sale (at $225 each) the next year. The list of inventions from Roezl down to the present time is a long one, in which the United States figures conspicuously. And from Roezl to re-

[1] Exquisite samples of ramie manufacture were in possession of the Department of Agriculture as long ago as 1867, received from Messrs. Joseph Wade & Sons, Bradford, England. During the last forty years, up to the present time, there have been factories in operation at various times in different parts of Europe which have produced ramie goods, etc., in almost endless variety. And some of these factories have sunk fortunes in their experiments.

Attention also is called to an announcement which appears in the latter part of this chapter of the practical results of Mr. Charles Toppan's experiments in degumming and spinning this product in the New England States.

cent years the literature of the subject has been a record of asserted successes. Yet, what is a practical ramie-machine? And what has been accomplished in France, where they are laboring so indefatigably to produce the successful decorticator?

Here is a record made by one of the best French machines in actual field-trials in 1888. With a single machine it required twenty-five days to decorticate the product of a hectare, or 2½ acres. With 20 acres, at this rate, it would have required two hundred days, and a farmer with one machine, decorticating three crops produced in a season, on 100 acres, would have to run the machine ten years, of three hundred working days each, to accomplish it. To state it differently, to decorticate at this rate the product of a single cutting on 100 acres, in one month of thirty days, would require eleven machines.

Mr. Hardy, ex-director of the botanical gardens, Algiers, calculates that a field of ramie over a year old, whose stems had reached a height of about 6 feet, would produce 48,000 pounds per acre of green stems and leaves, the leaves representing 20,400 pounds. This gives the weight of an acre of stripped stalks as 27,600 pounds. The best record of one of the prize machines at the Paris trials of 1889, working on green stalks with leaves, was about 132.8 pounds of stalks in eighteen minutes. At this rate it would require almost eleven days to decorticate the 48,000 pounds of stalks on an acre, or a year and eight months of three hundred working days to the year to clean a single cutting on 50 acres. Another prize machine decorticated 46 kilograms of stalks with leaves in eleven and one-half minutes. I was informed that there were 200 stalks in the bundle. Calling the time ten minutes, to avoid the fraction, we have 1,200 stalks an hour, or 12,000 in a day. It is claimed that Louisiana ramie produces 250,000 stalks per acre. At the above rate, working with one machine, ten hours a day, it would require twenty days and eight hours to decorticate the stalks on a single acre; and on 50 acres, with one machine, for a single cutting of ramie, it would require about three years and four months. It should be stated, however, that at an earlier trial, working on 36 kilograms, the decortication was finished in 2.35 minutes, which, after making due allowance for chips which were mixed with the ribbons, would reduce the time given above more than one half. In the eleven and one-half minutes required to decorticate the 46 kilograms of green stalks, 15 kilograms, or about 33 pounds, of wet ribbons were produced, equal to about 1,720 pounds, or 375 pounds of dry ribbons in a day. This shows that if it does require time to decorticate the 250,000 stalks on an acre of ground, a tremendous yield of fiber is produced, illustrating the productiveness of the plant in cultivation in a most forcible manner. See record on page 89.

The recent ramie literature is so voluminous that a tithe of the valuable points and suggestions presented could not be considered in the brief space of these few pages. It is my intention, however, to bring

together in one or two chapters for later publication as much of it as will prove of interest to the American students of ramie. In studying closely the recent American literature of this subject, one becomes aware of two things. That an array of interesting facts bearing upon many phases of the industry have been presented on the one hand; and that a great deal has been committed to "cold print," on the other, which amounts to useless reiteration of statements that were fresh a dozen years ago and which, it is to be regretted, are sometimes accompanied by other statements misleading and untrue.

I recall an exhaustive article on ramie which has lately had wide circulation through the South, in which a statement is made, evidently taken at random, from another source, to the effect that 250,000 tons of ramie ribbons are annually shipped to Europe from China, Japan, Java, etc.; and that a French firm (named) will contract for 10,000 tons of ramie monthly.

In a recent letter from Messrs. Ide & Christie, the London fiber brokers, discussing this very point of demand and supply, it is stated that ramie ribbons have at no time been shipped to Europe from any country in large quantity. Three to four hundred tons during the last five years would represent the maximum quantity brought from China, while India and other producing countries "have sent little more than sample lots and trial parcels." The largest lot of ramie ever received at any one time was in October, 1888, when 120 to 130 tons of ribbons were offered in the London market. There was nothing like competition for it, and I am informed that it was sold for "£8 to £9, less than half what it cost in China." I introduce these explanations at this time to illustrate the utter absurdity of the figures often given by careless writers (and as often referring to cost of production), and to prove also the truth of the statements made on a previous page regarding the present status of the ramie industry. I can but refer at this point to an article published about a year ago in the Kew Bulletin,[1] in which the writer says that "In a word, it is found that ramie fiber when produced

[1] These are the editor's conclusions: "In order to understand the present position of the ramie industry it would be useful to adopt some kind of classification of the details connected with it. In the first place we have the mere business of cultivating the ramie plant, and of producing stems with the fiber in the best possible condition. This is purely the work of the planter. Secondly, we have the process or processes necessary to separate the fiber from the stems in the form of ribbons and filasse. It is necessary for many reasons that this should be done either by the planter on the spot or by a central factory close at hand. Thirdly, we have the purely technical and manufacturing process in which ramie filasse is taken up by the spinners, and utilized in the same manner as cotton flax and silk are utilized for the purpose of being made into fabrics.

"For our present purpose we may take it for granted that the cultivation of the ramie plant presents no insuperable difficulty. Also that if a suitable selection of soil is made, and the locality possesses the necessary climatic conditions as regards heat and moisture, there is no reason to doubt that ramie could be grown to greater or less extent in most of our tropical possessions. As regards the second stage, in which

is practically unsalable in the London market at the present time." The demand has improved, however, within a few months, and prices are firm.

The Department, at this date, knows of no large market in this country where ramie fiber could be disposed of by farmers were they to produce it in quantity. Yet farmers are urged everywhere by interested parties to take up its cultivation, and we are in receipt of letters almost daily making inquiries upon the subject. Scores of replies have been received, also, in answer to the Department's Southern fiber circular, from those who have grown both jute and ramie in past years experimentally or in hope of profit. Some of the writers express disappointment that nothing personally practical has come out of their efforts, and by a few the matter is viewed in the light of a failure. A considerable number of the present inquiries come from those who know nothing of the past history of ramie cultivation in the United States, but who have been attracted to the subject by glowing accounts of the marvelous value of the plant as a textile, which have appeared in the columns of the press recently, and who are anxious to embark in its production. To these farmers its cultivation means the pursuit of a profitable new industry, and by holding out to such the golden promises that are frequently made in the journals of the day, only injury can result and the final establishment of ramie cultivation among the masses of southern agriculturists be retarded.

The object of making these statements is not to discourage farmers from going into ramie culture at all, but to induce them to take it up with their eyes open and to caution them to begin its cultivation on a small scale, until they know something about it by practical experience. Undoubtedly there is a great future for the industry, and the Department would encourage Southern farmers to make small beginnings in order to obtain needed experience. When a satisfactory and full demand for fiber can be assured, and the decorticator question is settled, it will be

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is involved the decortication of the ramie stems, the problem is by no means completely solved.

"On this really hangs the whole subject. The third stage is disappointing and unsatisfactory because the second stage is still uncertain, and being thus uncertain the fiber is necessarily produced in small and irregular quantities, and only comes into the market by fits and starts. It would appear that ramie fiber differs so essentially from cotton and flax that it can only be manipulated and worked into fabrics by means of machinery specially constructed to deal with it. Owing to the comparatively limited supply of ramie fiber hitherto in the market no large firms of manufacturers have thought it worth while to alter the present or put up new machinery to work up Ramie fiber. If appliances or processes for decorticating Ramie in the colonies were already devised, and the fiber came into the market regularly, and in large quantities—say hundreds of tons at a time, there is no doubt manufacturers would be fully prepared to deal with it. At present the industry is practically blocked by the absence of any really successful means of separating the fiber from the stems, and preparing it cheaply and effectively. This after all is the identical problem which has baffled solution for the last fifty years."—*Bulletin of the Royal Kew Gardens, December*, 1888, p. 298.

an easy matter to extend cultivation, and, if necessary, purchase machines for the decortication of the product. In spite of past discouragements there is a great deal that is hopeful. The very difficulties that have stood in the way of successfully establishing the industry have spurred to greater effort. The question is being studied from new points of view, and every aspect considered that may throw new light upon the subject, and new discoveries are constantly being made. Regarding the foreign trials Dr. Morris, the assistant director of Kew, has recently said editorially:

> To those generally interested in ramie culture it may be mentioned that the trials of 1889 have proved much more favorable than those of 1888, and the subject is evidently ripening for solution in many directions not thought of before.[1]

In the United States a great deal has been accomplished that is encouraging. But we must study the subject more carefully in the future in special relation to our own country, developing the industry on purely American lines, with regard to the conditions peculiar to our soil, climate, labor, and finally the manufacturer's demand for the product. We have yet a great deal to learn regarding the cultivation of the plant before we shall possess the practical knowledge, as it relates to this country, that the experimenters in France and the French and British colonies have obtained regarding its cultivation in these countries. It is one thing to grow ten acres of ramie stalks; another thing to produce such stalks that an even and uniform fiber may be obtained from the product of an entire field, and at different seasons. The result of studies in India some years ago suggested the suspicion that they might not have been experimenting at all with the plant which produces the celebrated "China grass-cloth," but with something that produces an inferior fiber. This is purely a suggestion, says one of these writers, "but it seems highly desirable that we should thoroughly examine all the plants met with in India which afford rhea-like fibers, as well as re-examine the plant from which the China grass-cloth is derived before much money be spent on experiments with new machinery." There are even two distinct forms of the fiber which come to the European market—from China—one bright and grass-like in appearance as viewed in bundle; the other darker, more greenish in color, and producing in manufacture indifferent results compared with the first. One of these grows in Southern regions and the other in the more temperate regions; one is used for fabrics, while the other finds employment in cordage and the coarser manufactures. I found great dissimilarity likewise in the filasse from stalks collected at the Exposition, grown in different remote regions, and run through the Favier machine at a private working in Paris. The American stalks produced a good fiber, equal to the French in appearance, but neither so soft or so silky as the filasse from stalks grown in Spain, though, possibly, the stalks may not have been fully matured.

[1] Kew Bulletin, November, 1889, page 274.

M. Favier informs me that there will be the greatest difference in the stalks from several cuttings. Some will be tough and unyielding, while others will give up their fiber readily, and it will be of the best quality. These suggestions are thrown out to urge upon the Southern growers who are interested in ramie culture the importance of making a most careful study of the cultivation of the plant under different conditions, that they may learn all there is to learn regarding it, and regarding best manner of growing it in American soil. And I would urge upon those who are experimenting with decorticators and processes to endeavor to obtain stalks grown in different sections and produced under varied *known* conditions, that all points may be fully covered.

Mr. Favier has produced certain good results in Europe by controlling under one direction and making consecutive the experiments with cultivation, decorticating, degumming, and manufacture.[1] In this way one condition is modified to meet the requirements of another, and with an intelligent oversight of the whole field the chance for mistakes through blind experiment is proportionately reduced and many difficulties successfully overcome. In the same manner, experiments in cultivation and the cleaning of the fiber should proceed together in the South to produce the best results, for the two branches of the industry are so closely connected, both necessarily must be carried on upon the farm.

One of the problems which we must settle for ourselves is suggested in the question whether it is best to decorticate the stalks green or dry. M. Favier favors the dry method and produces some strong arguments in support of his views which may be applicable to the situation in America. On the other hand, Dr. Morris and the French official experts offer strong counter arguments to prove that the drying of a large quantity of stalks is impracticable and out of the question. Certainly, if the ramie trials in Paris demonstrated anything, they demonstrated that there are many difficulties in the way of working a large quantity of stalks in the green state. In the limits of this report, however, there is little space for a proper discussion of all the pros and cons of the subject. Enough for the present to note some of the conditions which will confront the Southern ramie-grower, when the industry will have become general. A climate that will make it essential for him, if he works his stock green, to decorticate many tons in a very few days, or the ramie, just right when he commenced to work it, will often be too tough and dry for his green-working machines before he completes his crop. This means the use of many machines and a large force of laborers, who must be especially hired for the occasion. It also means the careful after-drying of tons of green ribbons, to avoid fermentation in mass, before he can bale them for market. Further than this, unless the coming ramie decorticator is a cheaper machine than those now under experiment, very few farmers will be able to purchase them, which will necessitate a central mill system. With such a system the harvest-

[1] See Summary of the Situation, at the close of this chapter.

ing of the crop green for immediate decortication is entirely out of the question. The transportation of 20 tons of ramie stalks even 2 miles, means the carriage of 16 tons of water that distance. Then if for any reason the stalks can not be put through the machines when received and must lie for twenty-four hours, a certain deterioration of the fiber will ensue from fermentation, or sometimes, from mildew. With the dry system a short-handed farmer would cure his crop in the field, house the stalks, or shelter them near by, and in a time most convenient for himself, in connection with the other work of the farm, attend to the cleaning of the fiber, or haul to the central mill as wanted. To summarize: If decorticated green the entire crop must be worked up in a very few days. If dry, a farmer can take his time, and, as we have shown, the best machines of to-day require a great deal of time.

Among the encouraging evidences of progress in the United States may be mentioned the renewed interest that has been developed, in the past year especially, not only in the South but in different parts of country, in the matter of experiments with machinery and processes for the preparation of the fiber. Even the cultivation of the plant is attracting attention in various quarters, and some new areas will be planted the present season, most of the work being under the direction of ramie companies, or conducted by men who have studied the question in all its economic bearings, and are supposed to know what they are doing. This is quite another matter from hap-hazard embarkation in the industry by individual farmers who have little money to risk in such enterprises, and less knowledge to guide them in an undertaking, where loss, under present existing conditions, is almost inevitable. In this connection reference is made to a letter produced in the chapter on jute and other fibers, which explains fully this point. This Texas farmer was induced to plant 20 acres of jute, on the promise that a decorticator would be available when the crop was ready to cut. His statement that the crop was never harvested because the decorticator was not produced is the melancholy sequel to the story. He has probably had enough of jute culture. A few Southern farmers have suffered from ramie culture in a similar manner.

On Oakbourne plantation, near La Fayette, La., I am informed that 90 acres of ramie were under cultivation last year, and as far as the question of mere cultivation was concerned the experiment was successful. I was informed also that ramie was decorticated on the farm last season, and several bales of the fiber sent to New Orleans, though nothing could be learned by the Department of their final disposition. Effort was also made to secure samples of the fiber, but none have been received up to the present time. Recent outside advices, however, prove that the promoters of the enterprise have found themselves confronted with the knotty decorticator problem, and for the present matters are at a standstill, though the experiments will proceed this season.

Through Mr. Felix Fremerey, of the Ramie Planting Association of Texas, located at Yorktown, it is learned that Mr. Frederick Natho, who produced the fine samples of ramie shown by the Department at the Paris Exposition, will plant a large area this season on the lands of the Pioneer Irrigation Company at Pecos City.

The Department is also informed from another source that small areas will be planted in Florida. The Ramie Company of America, of which Mr. Burnet Landreth, of Philadelphia, is president, will put in limited areas in Bristol, Pa., in Virginia, in Florida, and Alabama, the roots to be used for extending cultivation another year. I am also informed that there are plantations in North Carolina, South Carolina, and Georgia, and on the Pacific slope, where small areas will be grown the present season, and at some of the State agricultural experiment stations a few roots will be planted. It is to be hoped that the cultivation of these small areas, will continue, and that those who grow ramie even in a small way will make careful notes of their experiments and observations, for there is not the slightest doubt that the men who are most familiar with the details of the agricultural side of the question, when other questions have been satisfactorily settled, will be the first to profit from growing the fiber commercially.

The subject of American machines and processes is an interesting one. It was intended when the present report was being outlined to devote a chapter to their consideration. Very little material has been obtained, however, and rather than make an imperfect and incomplete report on this most important branch of the subject, it has been thought wisest to delay the publication of this matter until definite statements can be made. In this connection it is hoped that all who are interested in machines or processes for the cleaning and preparation of ramie fiber will send such descriptions of them, as they may see fit, with claims as to capacity, etc., to the Department of Agriculture, for record, or for examination if desirable. The recent correspondence in the fiber section of departmental work attests the wide-spread interest that exists in this matter, and it is earnestly hoped that further communications will be received. In this connection attention is called to Appendix B, at the end of the report.

Before closing this subject, however, it may be interesting to record the recent experiments of Mr. Charles Toppan, of Salem, Mass., in degumming and manufacturing ramie fiber from the raw product grown in China. Under instructions from the Department of Agriculture, last January I visited Mr. Toppan at his chemical laboratory in Salem, where the details of his process for degumming ramie were examined with greatest interest; thence to the works in Peabody, Mass., where the raw fiber is treated by the ton; and thence to Providence, R. I., where, in company with Mr. Toppan and his son, Mr. Arthur L. Toppan, Mr. John Richie, jr., of Boston, and Messrs. Thomas Mabbett and Benjamin M. Earle, of Providence, the entire process of preparing and

spinning the degummed ramie on woolen machinery was witnessed to the point of yarn production. The yarn has already been produced in quantity, and I am informed finds a ready market in New York City, at good prices. In a recent letter received from Mr. Toppan he says:

I am now carding and spinning yarns on both woolen and cotton machinery, no changes being made with either. I have spun commercially both coarse and fine yarns, and this by the ton. These yarns bring 75 cents to $1 per pound in the gray; and in colors $1.50 to $2 per pound. You will note in the samples sent I have a jet black—a color never produced in ramie before, as I am informed. Cotton, worsted, and silk colors all take readily and are fast. We are in the market for American-grown ramie, paying the market price for the same quality of ramie ribbons that we are now using. The decortication is an important part of the treatment. There are many decorticators in the field, all having the same vital defects regarding quantity and simplicity of construction.

Recently some beautiful samples of fringes have been received from Mr. Toppan, which are already on the market, and orders have been received by him for yarns for the manufacture of sail cloth, hard twisted yarns for hammocks, and some other manufactures, specimens of which are early promised.

From a knowledge of Mr. Toppan's process I am satisfied that the important results he has attained in the manufacture are due to the fact that the degumming is carried only to the point where a filasse is produced, which, when separated and broken into short lengths on the fearnaught and garnet machines, is sufficiently soft and pliant to work well on woolen machinery.

It should be borne in mind, however, that the fiber, in the condition in which it is left after drying, is only applicable to one form of spinning. In Europe, ramie has been worked almost wholly upon line-spinning machinery, where it is necessary to keep the filaments straight, or parallel, like flax or silk. Both silk and woolen machinery have been used abroad, of the latter, that for working "long wool," though the use of flax machinery, with modifications to adapt it to all the reqirements of the new fiber, has been thought to give the best results. With the process under consideration there is more or less tangling or interlacing of the filaments which would make it quite difficult to prepare the fiber for line spinning without some loss. Even with the best systems of degumming followed abroad, and I was told there were several factories for the purpose, there is more or less of this trouble, and in French manufacture a large percentage of waste fiber is produced which must be sold at a low price for other uses. It would appear, therefore, that perfectly satisfactory results in this branch of the manipulation of the fiber have not been attained in either country. Mr. Toppan's discoveries are important, but to this extent he does not cover the whole ground. This tangling of the filaments, when the fibrous mass is manipulated in solutions, is one of the many difficulties that enter into the ramie problem. Regarding the Toppan experiments, however, this much is proved, that by spinning a short length fiber in

the form of wool, it is possible to utilize all "waste" from combing, even should it amount to 60 per cent., in a form of manufacture that makes it about as valuable as the straight fiber that has been combed out. If these New England experimenters have done nothing else. they have shown how to degum and spin ramie in an economical manner, and have been the first American manufacturers who have actually placed ramie products on the market, and made a demand for the raw material in large quantities.

Since the preparation of this report a small sample of cloth for suitings has been received from Mr. Burnet Landreth, president of the Ramie Company of America. A few yards of this fabric were manufactured for the company (made February 20, of this year) on woolen machinery, from American and Chinese ramie, a very little cotton having been mixed with the fiber to facilitate the operation of spinning. Figures as to price of the goods were not given, nor the name of the woolen mill stated. The American ramie was grown on the farm at Bristol, Pa.

There are two forms of the Chinese product, as has been previously stated, the white and the green, costing practically the same as imported, yet in manufacture showing considerable difference in value from a variation in the percentages of loss both in preparation and spinning. This suggests the idea that when ramie is grown commercially in America there will be great differences in quality at first, and a new difficulty will arise, of establishing standards and fixing values. And in this connection I shall await with great interest the result of the first trials of manufacture with American-grown ramie produced in commercial quantity. The imported "grass" thus far has been used in manufacture, and if Mr. Toppan's enterprise should be greatly extended, it is a question whether he will not find himself in exactly the same position in which other ramie spinners in Europe have found themselves placed—hampered by a small and uncertain supply of the raw material. Mr. Toppan states that he will purchase American-grown ramie at the market price of the foreign, if it is of the same quality, which, with duty and transportation across the sea added, amounts to about 9 cents a pound.

As to the question of quality, the Chinese article, as hand-stripped and cleaned, is brighter than any machine-prepared I have yet seen, some of the machine-prepared being simply in the form of ribbons or flat strips of fiber with the outer pellicle still adhering. This could not be graded with the thoroughly cleaned imported grass, though the Providence manufacturers would prefer it in this form to ramie cleaned chemically, which might not give so good results with their process. Those who may have ramie to sell in the future, therefore, will do well to ascertain the exact form in which it will be purchased.

SUMMARY OF THE SITUATION.

From the foregoing it may appear to some readers of these pages that the situation is rather discouraging. It can only be regarded so in the light of the rose-tinted statements frequently made regarding the industry, wherein are set forth the ease and profits of cultivation, with no whisper as to the reasons why the industry has not been established. Having glanced at the facts of the case, let us summarize the situation. The European supply of commercial ramie (that which can be purchased in open market) comes from China. It is produced there in a small way and prepared by tedious methods, which give but a very few pounds of the "China grass" a day—less than 2 pounds, one writer asserts—the operations, according to Michotte, being as follows: The freshly cut stalk is stripped of its leaves and scraped with a bamboo knife to raise the pellicle or outer bark. This done, the fibrous part is extracted in small ribbons. The further preparation consists in boiling these ribbons in lye water; that is, in water and ashes. They are then spread out upon the houses to dry, the operation being repeated several times, the final result being the extraction of about 25 per cent. of the gum.

In manufacture the filaments of ramie are deftly tied or joined together, end to end, and the delicate thread thus formed is woven into the wonderful fabric that bears the name of China grass cloth. With only such rude preparation of the filasse and laborious manufacture the situation would be indeed discouraging, yet for hundreds of years ramie has been manufactured in this manner in Eastern countries. Contrast with these statements some of the facts brought out in this report. From a production of 2 or 3 pounds of ribbons per day by one man, we can now produce by existing machines (even though they are not fully satisfactory) over half a ton of ribbons in ten hours. The record of one of the trials of the Landtsheer machine, at Paris last summer, demonstrated that 22 pounds of wet ribbons could be produced in two and one-half minutes, which, with an allowance of 20 per cent. for chips and refuse, is equal to 1,400 pounds of dry fiber per day; and a later trial of the Favier machine demonstrated a capacity of 1,100 pounds in a day of ten hours. In this connection the importance of a thorough official test of American ramie machines can not be too strongly urged, in order that we may know precisely what America is doing in this direction, and that American inventors may have an opportunity to prove their claims and compare results with their French confrères.

The results of the foreign trials have inspired such confidence in the establishment of the industry in the near future that ramie companies are forming everywhere. In our sister republic of Mexico large tracts of land have been set aside for ramie culture and planting begun, and I am informed that French and American machines will be imported into the country to make practical field tests the present season. The South American republics also are active. In Venezuela alone some 2,500 acres

of land have been given by the Government to a ramie company, which has already made a beginning with cultivation. Even Cuba is interested in the new fiber, and a year ago imported French machinery for actual field experiment, and fiber has been produced in salable quantity in the Sandwich Islands.

It is worth recording that the French Ramie Association ("*La Ramie Francaise*"), of which M. P. A. Favier is the head, put in operation last year three decorticating establishments in France, Spain, and Egypt, respectively. The association has also a spinning mill operating 2,500 spindles. Its contracts with agriculturists cover 350 hectares of land in the three countries named above.

I have shown in another part of the report how long a time is required to decorticate the product of 50 acres with *one* of the present machines, but only a hint was given of the tremendous yield of fiber that can be produced on an acre of ground. In France, it is claimed, by estimates based on the weight of stalks that can be produced on a hectare, and after considering the expenses of cultivation and decortication, that an income of 1,500 francs per hectare is possible the third year. This is equal to about $120 per acre. There is no question but that ramie culture will pay well when the industry is fairly established; and the very fact that it will prove so remunerative will spur to greater effort to overthrow all remaining obstacles.

JUTE AND OTHER FIBERS.

Regarding jute there is little that can be added to that which has previously been said in the many reports emanating from this Department. It has been satisfactorily demonstrated over and over again, that we can produce a fine quality of fiber and in any quantity. The nearer approach to a successful solution of the ramie machine problem is most encouraging for jute culture. There are a number of machines in the United States that are claimed to have done fairly good work, we are well aware, and we are hoping much from them, though, if asked to do so, the Department could not, at the date of publication of this report, refer its correspondents to a purchasable machine upon which the decortication could be economically accomplished. We have even endeavored to place a description of one of these machines before the readers of this report, because of the claims that have been made for it, but when the mechanical drawings were received the Department was requested, for reasons given by the inventor in the letter accompanying, to publish only an indication of the principle with a statement of what the new machine would do when completed. Under such circumstances the Department can only wait until positive statements can be made. A machine that will decorticate ramie will strip jute, and probably, with some slight changes, other bast fibers. The problem which has confronted the world with regard to ramie is almost identical, therefore, with that which has proved the stumbling block of the jute industry and other good fibers as well.

For the benefit of those who may wish to make a trial with jute, a brief description of the cultivation of the plant will be given, though the remarks that were made regarding the advisability of farmers going into the culture of ramie apply equally to this fiber. Here is an extract from the Texas letter referred to on a former page:

I was handed a circular from your Department making inquiry about fibers and their culture. Something more than two years ago a man came here (a Frenchman) and organized a jute manufacturing company with a subscribed capital of $25,000. The same party had a decorticator which he was to furnish to work up the jute ready for manufacturing purposes. In order to get the thing started they made a contract with me to plant, cultivate, and harvest 20 acres of jute at $20 per acre, the company to furnish the seed. I had black land, part loam, and about one-third stiff land. I prepared the land by breaking with two-horse plow and harrowing well. Planted first about 15th to 25th of March, which proved to be too early. The seed rotted in the ground. I planted about two-thirds of it over about the 1st of May, which made

it a little too late to obtain the largest growth. The second planting I got a good stand and it all made a very satisfactory growth from 6 to 9 feet high, with an average of about 7 ½ feet. It is very tedious to work with when it first comes up, and requires the weeds and grass to be cleaned by hand-picking, as no tool can be used to work among the plants. This crop was raised in 1888, and was never harvested. The man that organized the company was to have the decorticator here by the time the jute was ready to cut, but he went from here to New York and we lost track of him, so we had no machinery to work the crop with. The crop bore an abundance of seed, but the pods burst open and spilled the seed out. With machinery to separate the fiber we can raise either jute or ramie on our valley lands. * * *

The extract tells its own story and comment is unnecessary. Reference may be made also to an item in the Manufacturers' Record to the effect that a prominent manufacturer in Ohio will buy 2,500 tons of jute fiber the present season, and pay 4 cents a pound for it. The market price for the imported article in the New York market is from 2½ to 4½ cents. If our Southern farmers have means to decorticate it, and can grow it with a profit to themselves and sell the cleaned fiber at 4 cents a pound, there is probably a large demand for it already, because what one jute manufacturer can afford to do another can do, and if a prime article is produced, no manufacturer can lose anything at the figure quoted. It is stated that jute can be grown in Texas at a cost of 2⅙ to 2⅓ cents a pound, and yield the farmers $40 to $60 per acre.[1] This is a very good showing, but at the same time we would advise no one to go into the culture extensively until he has assured himself, by a knowledge of every step from seed to fiber, that he can produce it profitably. Undoubtedly when these fiber industries are fairly started, and a steady market is assured, they will be the means of putting considerable money in the pockets of the Southern farmers, a consummation devoutly to be wished, and for the realization of which the Department of Agriculture will do all in its power.

The following regarding the cultivation of jute is by Mr. Felix Fremerey, before referred to, who has had practical experience in its cultivation. The two varieties are *Corchorus capsularis* and *C. olitorius*.

The seeds of both varieties are sown as soon as the soil gets warm—about the beginning of April—in drills some 5 or 6 inches apart, taking about 15 pounds of seed to the acre of the former, and, of the latter, about 20 pounds.

The *olitorius* kind growing faster, its stalks will be matured enough for cutting in about seventy or eighty days after sowing. When the stems have reached a length of some 8 or 9 feet, its filasse being a very fine structure, it will command a higher price. The *capsularis* stems will grow to a height of from 9 to 10 or 11 feet in about eighty or ninety or one hundred days, when they should be cut. In every case none of either species should be allowed to grow any longer than to their blooming time, by risk of the stalks branching out and rendering their decortication very difficult if not impossible. The best mode for cutting is by means of a mowing-machine having a dropper attachment. Farmers not having a degumming apparatus at their disposition will be compelled to operate this manipulation in a pool or tank, or in running water. The ribbons, before getting dry, are tied in bundles of from 50 to 60 pounds and carried to the water, where the decomposition of the glutinous matter is

[1] These figures are given on the authority of Prof. S. Waterhouse of St. Louis.

achieved in six to ten days, according to the degree of the warmth of the water. When the gum is properly destroyed by fermentation, the fibers are submitted to a thorough washing, then dried in the sun or some place in the barn, when they are ready for packing. The market price of jute filasse is mostly dependent upon the care in its preparation.

The earlier experiments of the Department proved that the plant requires a hot damp climate and a moist soil of sandy clay or alluvial mold.

The advantage of jute production to the South is made apparent by a glance at our jute imports in a single year. These amount to a total of $7,000,000. The latest quotations per pound for the different grades of jute are as follows:

	Cents.
Jute butts, bagging quality	2⅝
Jute butts, paper stock	1⅜
Rejections	2–2⅛
Jute (fiber)	2½–4½

If jute is placed on the free list with sisal, manila and other foreign cordage fibers it will be very difficult to compete with it, for prices are low now. But it is said that American agriculture can receive no benefit from a duty on jute, because farmers can not produce it commercially for want of decorticating machinery. Recalling the interest in the jute bagging question, it should be borne in mind, however, that if we are not growing jute we are producing a good quality of bagging from low-grade cotton, and also from pine fiber. And with the thousands of tons of flax straw produced every year on western farms, and which now is wasted, every pound of jute imported for bagging purposes represents so much money that ought to go to the farmers of our own country.

OTHER FIBERS.

Considerable interest has been aroused recently in regard to okra. This plant, which thrives everywhere in the South, furnishes a valuable fiber, some very fine specimens of which have lately been received. Sisal hemp can be grown in Florida, remarkably fine samples of this fiber also having been sent from several localities. But the catalogue is a long one, many interesting additions to the list having been made in the last two or three months, including a malvaceous plant growing wild over several States, the fiber of which, grown in India, is stated to be more valuable than jute.

There are many other fibrous plants, that are now growing or that can be grown in the South, of which considerable might be said. The investigation, as it relates to these Southern fibers, however, has hardly been more than begun; and while a great deal of important information has already been collected, so much ground has yet to be covered that it must be left for the later report.

To conclude, within the length and breadth of our country we have resources in this direction the proper development of which would put millions of dollars in the pockets of American farmers annually, and save to the United States immense sums now paid to fiber producers in other countries. It is to be hoped, therefore, that the farmers of the United States, North and South, will study the question as it relates to themselves individually, with the end to securing all information possible that may help them to make a beginning. The success of any industry depends largely upon how well it is conducted. With new or untried industries there is all the more necessity to make haste slowly. An intelligent appreciation of the whole situation will go far towards bringing about the desired result in regard to fiber culture, while spasmodic and hap-hazard attempts to set it on its feet will only result in disappointment and failure, and put us back a decade.

APPENDICES.

Appendix A.

BOTANICAL CONSIDERATIONS ON THE RAMIE QUESTION IN FRANCE.

The following considerations, touching upon the species and varieties of ramie cultivated in France, are taken from statements made by M. P. A. Favier, in "*La Ramie.*"

In our description we will preserve the denominations adopted by the greater number of those who have treated upon this subject but, as in the varieties which we are going to describe, and of which we have the living species before our eyes, we do not recognize but two really distinct species, we will avoid the first confusion by making the distinction in our agricultural practice of two species only, which we denominate white ramie and green ramie.

In the white ramie we possess two varieties, to each one of which we will apply the name best adapted to the appearance of the plant. To that one which has the under part of the leaf entirely silvered, and is snow-white, we will preserve the name of "*nivea*," while to that which has the under part of the leaf only approaching the white, we will apply the name of "*candicans.*" The *nivea* has the leaf slightly tapering towards the petiole. The upper part of the leaf is bright green and the lower side is a uniform white, which is entirely silvered over in the young leaves, and which takes on a regular grayish white when they become matured. The veins on the under side are slightly colored. The dry leaves recover their whiteness and the veins preserve a reddish brown coloring. This species resists cold better than the greener species, and could perhaps be acclimated in the southwest. It is this species which Colonel Nicolle is said to have cultivated with success at Jersey, in the British Channel, and in Dordogne.

Its vegetation is earlier than that of the other species, but its yield is inferior in quality to the green, as it produces less stalks, and does not grow as high as that; the quality of the fiber is also less resistant and much less abundant. It is, in our opinion, the same as they cultivate in China under the name of *Tchou-Ma*, and which produces the magnificent fiber which comes to us from that country. In Europe, during the first years of the plantation, this has a tendency to ramify, and the stalks present the difficulty of becoming withered in desicca-

tion, which robs it of a great part of its value. This difficulty seems to disappear in the older plantations.

The *candicans*, in the description of which we made some reservations in our preceding edition, is the species which had been introduced into the south of France under the name of *nivea*. It resists cold still better than the *nivea*. It is the species which was tried in Belgium in 1860. In the garden of acclimation, in Paris, it can pass the winter in the open grounds, while the other forms have to be sheltered. It has on the under part of the leaf a less decided white appearance than the *nivea*. The veins are of a grayish white tint which conforms to the color of the groundwork of the leaf as its development progresses. As in the *nivea*, the white loses its intensity in proportion as the leaf approaches its maturity, and remains a grayish white after desiccation, with the veins brown. The upper side of the leaf is dark green, and it is more tapering towards the petiole than the *nivea ;* but all these differences must be carefully observed to prevent confusion between these two varieties of white ramie. This has a growth lower in stem than the green ramie, or the *nivea*, and this is its most distinctive characteristic. Its tendency to ramify is so great during its first years that it often grows in quite bushy forms. This objection disappears also in the older plantations, but the stalks remain slender and short and although they may grow thickly the agricultural yield is very inferior.

The *utilis* or *tenacissima*, or green ramie, has the leaf quite heart-shaped toward the petiole. In this it is quite distinct from the varieties of white ramie, in which the leaves are more tapering towards the petiole, and this difference alone makes it easy to distinguish them. The upper part of the leaf is light green, the lower part is also light green, sometimes covered with a grayish down, which appears in the squares formed by the veins. These veins, which are slightly paler than the green of the leaf, are very prominent. This species has a very vigorous growth; it produces the highest and most numerous stalks and the quality of its fiber, which is more abundant than in any of the other species, is of the most tenacious kind, making it well worthy of the name of "*tenacissima*." It grows in the warmest climates, but can resist cold to the extreme of 6 to 8 degrees, and even support 10 degrees (centigrade) by taking certain precautions, but it requires a high and even temperature during the period of vegetation. This is the species which we recommend to be cultivated in the south of France, in Spain, Portugal, Italy, Egypt, Algeria, in our colonies, and wheresoever the climate will permit, because of its agricultural yield, which we estimate at one quarter more than that of other species, and because of the superiority of its fiber in spinning into thread. Manufacturers will purchase the product of this species at a higher price than the others, which can perhaps be cultivated in certain countries but with smaller yield.

Appendix B.

CIRCULAR OF INQUIRY IN REGARD TO FIBER CULTURE OR MACHINERY.

The Department is extremely desirous of obtaining all information possible from those who may have interesting statements to make regarding success or failure with the cultivation, experimental or otherwise, of various fibrous plants in the United States. The question of machinery or processes for the preparation or decortication of fibrous plants is also an important subject of inquiry, and all who are interested in matters pertaining to either branch of the investigation now being pursued by the Department are earnestly solicited to aid the Department by such brief statements as they may feel inclined to present. The following circular in relation to this matter was sent out at the beginning of the present year.

FIBER INVESTIGATION.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., January 1, 1890.

SIR: The interest in fibers among farmers and others, and the necessity for extending the range of agricultural production as the numbers of rural laborers increase, have led to an investigation in Europe and in this country which is intended to be as thorough and practical as possible.

During the last twenty years, at various times and in many localities in the United States, experiments have been undertaken relative to the cultivation of a number of fiber-producing plants indigenous or introduced, a list of which is given below. The Department is desirous of securing information from every source bearing upon the success or failure of experiments with the cultivation of any of these fiber plants, and I beg to call your attention to the following questions, hoping you will be able to aid us with information upon the subject as far as possible, without, however, taxing too severely your time and patence:

LIST OF FIBROUS PLANTS.

Flax, *Linum usitatissimum.*
Hemp, *Cannabis sativa.*
Ramie, or China grass (*Boehmeria nivea*).
Indian jute (*Corchorus olitorius and capsularis*).
Okra (*Abelmoschus esculentus*).
Swamp rose mallow (*Hibiscus moscheutos*).
Indian mallow, "American jute" (*Abutilon avicennæ*).
Bear grass (*Dasylirion graminifolium*).
American aloe, (*Agave Americana*).
Sisal hemp, "Henequin" (*Agave-Sisalana*).
Spanish bayonet, Adam's needle, etc. (*Yucca;* species).
Palmetto (*Sabal* and *Chamærops*).
Pine apple, *Ananassa sativa*, and *Bromelia*—species.

There are many other plants on the Department list, but the above are the principal ones.

INFORMATION DESIRED.

1. Names of fibers from above list grown either in large or small quantities, for experiment or otherwise, at any time during the past twenty years, in your locality or State, and names and addresses of experimenters or growers of such fibers, stating as far as possible the extent of experiments and the period or year when such experiments were made or the plants cultivated.

2. Names of any person or persons who are or have been interested in any form of new machine or device for the extraction of fiber of above plants, or any fiber-producing plants in your State, as well as name of any persons who have experimented in any way with the extraction of fiber from fiber-producing plants.

3. If you have had any personal experience in the cultivation or manipulation of any of the above fibers, brief statements relating to such experience, with accounts of success or failure, will be thankfully received.

Very respectfully,

J. M. Rusk,
Secretary.

The interest in ramie machinery and processes is increasing. Our country has held a prominent position in the field of invention, in this direction, since the revival of the question of ramie cultivation a quarter of a century ago. The Department has records of many of these machines and processes, but it is important to complete the list, and especially in regard to proposed official trials of ramie or other fiber machinery that may be made at some future time.

Those who may wish to submit samples of any fibers, or even specimens of indigenous fiber-producing plants (and such are invited) will, upon receipt of a letter indicating the fact, receive instructions for forwarding the specimens without cost to the sender for postage. Communications on this subject should be addressed to the Secretary of Agriculture, the words "Fiber Investigation," also being inscribed on the envelope, in one corner.

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